BRITISH JOURNAL OF TUBERCULOSIS AND DISEASES OF THE CHEST

Vol. XLIII. July, 1949 No. 3.

GENERAL ARTICLES

CAVITIES OF THE LOWER LOBE IN PULMONARY TUBERCULOSIS

PATHOLOGY AND TREATMENT, WITH SPECIAL REFERENCE TO PNEUMOPERITONEUM

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THE objects of this paper are to review the place of pneumoperitoneum as a form of collapse therapy, to survey patients so treated in this hospital, and discuss the pathology of lower lobe cavities. It is believed that pneumoperitoneum, of all the different methods of collapse, is probably the best initial form, and sometimes is the only treatment indicated for cavities of the lower lobe.

There are three main reasons for dealing with this subject. Lower lobe cavities have their own characteristic features which deserve special consideration and determine the line of treatment. The incidence of cavities so situated is comparatively low, so that the literature dealing with them is still scanty, and there is difference of opinion on the most suitable type of treatment (for example, Seidel, 1948, and Chatard, 1948). Moreover, there is still much controversy about the value of pneumoperitoneum treatment. Although it has many advocates, used as a sole measure (Trimble, 1948), some are critical (Hurst, 1947) or even reject it (Naegeli, 1948, Chatard, 1948). There are similar doubts of the value of phrenic paralysis for closing cavities.

Artificial pneumoperitoneum was first used by von Mosetig-Moorhof in 1893 for treating tuberculous peritonitis. Banyai first applied it to pulmonary tuberculosis (1931), but only accidentally. In 1933 Vajda and independently Fici and Culotta, deliberately adopted pneumoperitoneum in the treatment of pulmonary tuberculosis. In 1934 Banyai combined it with paralysis of the diaphragm for the same purpose.

The optimum duration of pneumoperitoneum treatment is not yet established. According to Trimble (1948), it should be maintained for four to five years. Banyai (1946) prefers to continue for another year or two from the time it becomes effective.

Clinical Material and Methods

In our cases phrenic paralysis, mostly temporary, has always preceded pneumoperitoneum. Usually this has been started five to seven days afterwards. There were, however, 3 cases where pneumoperitoneum followed six to ten months later. A period of previous bed-rest was given for collapse treatment shows better results if done when the activity of the disease is diminishing, and not during an acute phase. In most cases one to two months of complete bed-rest were sufficient for this purpose. We usually made the puncture one or two finger-breadths outside the left rectus muscle, two or three finger-breadths below the costal margin. Sometimes, if difficulties were met, as from peritoneal adhesions, we chose a point on the linea alba, two to three finger-breadths below the umbilicus. Areas of previous surgical scars must be avoided, as intestinal loops adherent to the abdominal wall are likely to be there and present danger of perforation. Refills of 800 to 1,000 c.c. of air were given at weekly, seldom semi-weekly, intervals as determined by the position of the diaphragm fluoroscopically, and by the reaction of the patient. We preferred to reduce refills rather in amount than in frequency, where necessary.

A series of 43 patients were studied, all with lower lobe cavities and positive sputum, and all receiving various collapse treatments. Illustrative case reports and radiographs are given in the appendix. All films were taken at the height of inspiration. The dorsal situation of each cavity was confirmed by a lateral X-ray film. Only in one case " extension " of a " dorsal " cavity above the interlobar fissure was observed in the postero-anterior view. A few cases required an oblique view for the following reasons: in three a large " basal " cavity situated in the retro-cardiac space was not visible in the postero-anterior view because of shielding by the heart silhouette; in two others a " dorsal " cavity was not seen distinctly on a lateral film because of the spinal shadows. Tomograms were not used for cavity location, but were taken for assessing cavity closure when there was a doubt.

These 43 cases with lower lobe cavities were met in a series of 658 patients with pulmonary tuberculosis, chiefly males, treated during the past four years in this hospital. Three of the 43 patients were between eighteen and nineteen years of age, 26 between twenty and thirty, 4 between thirty-one and forty, 6 between forty-one and fifty, and 4 between fifty-one and fifty-five. The following collapse measures were adopted: (1) Paralysis of diaphragm; (2) paralysis of diaphragm supported by pneumoperitoneum;* (3) artificial pneumothorax; (4) pneumothorax supported by paralysis of diaphragm; (5) pneumothorax supported by paralysis of diaphragm and pneumoperitoneum; (6) extrapleural pneumothorax supported by pneumoperitoneum; (7) thoracoplasty. The period of observation extended from January 1945 to May 1949. Evaluation of the treatment was based on the radiological picture, sputum examination (amount, character and bacteriological analysis by direct smears, concentrations and cultures of twenty-four-hour specimens), blood sedimentation rate (Westergren), weight, temperature range, pulse rate, physical examination (this is of comparatively little importance as many

* Pneumoperitoneum was used with phrenic paralysis in all the cases of the present series except one, and so " pneumoperitoneum " means in this paper the combined procedure.

lower lobe cavities are mute), and the general condition of each patient before and after treatment. Only those findings were evaluated which were confirmed by repeated examinations. "Negative sputum" means at least two series of five consecutive negative concentrations confirmed by culture with no growth of tubercle bacilli. If sputum was not obtainable, fasting gastric contents were examined. The longest observation period in the present series was forty months. In view of the different incidence, features and prognosis of cavities located at the apex of the lower lobe ("dorsal" cavities), and those in other parts of the lower lobe ("basal" cavities), each group was dealt with separately.* "Parahilar" cavities whose exact situation was doubtful were excluded.

The cases were divided into two groups: (1) "moderately advanced"—cavities in lower lobe, and on one side only, and (2) otherwise—"far advanced." The results were grouped as follows: (A) "Very satisfactory"—no signs of an active process (cavity not visible in X-ray, sputum conversion to negative at least for three consecutive months, blood sedimentation rate as well as temperature range and pulse rate were normal, general condition good). (B) "Satisfactory—cavity not visible, sputum conversion at least for three consecutive months, but some other signs and symptoms still present. (Patients in group (A) and (B) were considered quiescent†). (C) "Improved"—(*a*) cavity not visible, but sputum conversion for less than three months or not yet achieved, or (*b*) cavity smaller and improvement in general condition.‡ (D) "Unimproved"—even if general condition was better, but no sign of local improvement. (E) "Deteriorated"—progressive breaking down, regardless as to whether the initial cavity is still visible or not. (F) Dead.

Results

The results were analysed with reference to the extent of disease, to cavity location (whether "dorsal"§ or "basal"), and to the type of collapse given (see Table I).

Table II subdivides the "satisfactory" results with pneumoperitoneum treatment according to the time which was needed for cavity closure, for "dorsal" and for "basal" cavities separately.

Table III summarises the various complications and disadvantages of the applied collapse measures in respect of cavity location, and shows how advanced the case was.

* These differences may be explained partly by the fact that the apical and basal parts of the lower lobe are two different broncho-pulmonary segments supplied by two branches of the lower lobe bronchus which are separate from each other. The apical segment may be partly or even completely separated from the rest of the lower lobe.

† "Quiescent" cases in which the general condition and exercise tolerance are good, having regard to the extent of the lesion; no evidence of toxæmia; no tubercle bacilli found on three consecutive monthly examinations by stained film; and changes revealed by other clinical investigations and by serial skiagrams pointed to retrogression of the tuberculous lesion. (According to the classification approved by the Ministry of Health.)

‡ In 2 cases where the cavity shrunk markedly and sputum conversion was observed for five and six consecutive months respectively, an open healing of the cavity cannot be entirely excluded. Because of this uncertainty these cases were classified as improved.

§ For convenience the term "dorsal" is purposely used instead of a more correct one: "apical of the lower lobe."

TABLE I.

Cavity Location.	*Disease Extent.*	*Final Type of Collapse.*	Results. *Very Satisfactory.*	*Satisfactory.*	*Improved.*	*Unimproved.*	*Deteriorated.*	*Death.*	*No. of Cases.*	*Remarks.*
Dorsal	Moderately advanced	A.P.			1	1			2	
		Phr.	1						1	
		Phr. plus PP.	2	4	1	2	2		11	
		Phr. plus PP. plus A.P.	1			1			2	A.P. failed and was reinforced by PP.
		Extrpl. A.P. plus PP.		1					1	PP. by itself proved a failure.
		Thoracoplasty	1						1	Previous treatment with A.P. plus PP. unsuccessful.
		No. of cases	(5)	(5)	(2)	(4)	(2)		(18)	
	Far advanced	A.P.	1						1	
		Phr. plus PP.		2		2			4	
		No. of cases	(1)	(2)		(2)			(5)	
		No. of Cases	6	7	2	6	2		23	
	Moderately advanced	A.P.	1	1			1		3	
		Phr.				1			1	A.P. was added to the unsuccessful phrenic paralysis.
		Phr. plus A.P.	1						1	
		Phr. plus PP.	2	1					3	In 1 now satisfactory case the cavity closed upon 3 months' bed-rest as the only treatment, but reopened 4 months later.
		No. of cases	(4)	(2)		(1)	(1)		(8)	
Basal	Far advanced	Phr.		1		1		1	3	
		Phr. plus PP.		1	1		2		4	Two successful cases had previously undergone a partial thoracoplasty. One of the deteriorated cases (in respect of collapse treatment) died some time after PP. abandonment.
		A.P. plus PP.					1		1	
		Phr. plus PP. plus A.P.		1			1		2	Improvement after PP. abandonment.
		Phr. plus PP. plus streptomycin (1·0 gm. daily intramuscularly)		1					1	Previous partial thoracoplasty. Phrenic plus PP. unsuccessful.
		Thoracoplasty		1					1	A.P. failed. Operation performed without delay because of a dangerous uncontrollable hæmoptysis.
		No. of cases		(5)	(1)	(1)	(4)	(1)	(12)	
		No. of Cases	4	7	1	2	5	1	20	
		Total	10	14	3	8	7	1	43	

N.B.—Where A.P. is mentioned it often includes intrapleural pneumolysis or thoracoscopy.

TABLE II.

Cavity Location.	*Duration of PP. in Months.*	*No. of Cases with Disappearance of the Cavity in X-ray.*	*No. of Cases with Converted Sputum.*	*No. of Cases with Converted Sputum and Visible Cavity.*	*Remarks.*
Dorsal ..	Up to 3	5	2		P.P.
	4 to 6	2	3		
	7 to 12		1		
	13 to 17		2	1	
No. of quiescent cases		(7)			
Basal ..	Up to 3	3	1		
	4 to 6		3	1	
	7 to 12	1	2		
	13 to 18	1			
No. of quiescent cases		(5)			
Dorsal ..	4 to 6	1	1		In combination with A.P.
No. of quiescent cases		(1)			
Basal ..	Up to 3	1	1		
No. of quiescent cases		(1)			
Dorsal ..	Up to 3	1	1		In combination with extra-pleural pneumothorax.
No. of quiescent cases		(1)			
Basal ..	Up to 3	1	1		In combination with streptomycin.
No. of quiescent cases		(1)			
Total of quiescent cases		16			

The observations in this series can be summarised as follows:

Cavity location in the lower lobe was rare (6 per cent.).

In 10 cases (1·5 per cent.) the disease affected the lower lobe only (" basal tuberculosis "), 5 of which had " dorsal " and 5 " basal " cavities. In the rest the disease had invaded the lower lobe by extension from one of the upper lobes; in this last group there were 13 cases with cavities in the upper lobes.

There were slightly more " dorsal " than " basal " cavities, but some " parahilar " cavities with a doubtful location were excluded. The same proportion was observed among cases with a basal onset.

The right-sided location was more common (24 and 19 cases respectively).

Nearly one-quarter of the cavities, both " dorsal " and " basal," have shown fluid levels.

Five cavities appeared to be tension cavities; four of them were " dorsal." Two of the tension cavities showed fluid levels.

More than half of the cavities (56 per cent.) have closed upon collapse treatment. A similar proportion was maintained for " basal " and for " dorsal " cavities as well. For cavities with a basal onset the results were even better (7 quiescent cases out of 10). " Moderately advanced " cases responded better than " far advanced " cases. In 3 quiescent and 1 improved case healing of tuberculous ulcerative laryngitis was observed.

There was a large proportion of " far advanced " cases which may be the result of two factors: (*a*) frequency of spread when a cavity exists, and (*b*) quick progression to cavitation of lower lobe lesions. In 2 cases admitted with an infiltration in the lower lobe (1 case had a basal onset), a progression of these lesions to cavitation was observed within a few weeks.

TABLE III.

Complications and Disadvantages of Relaxation Measures observed in the Present Series.	*Dorsal Cavities.*		*Basal Cavities.*		*Type of Collapse.*	*No. of Cases.*
	Moderately Advanced.	*Far Advanced.*	*Moderately Advanced.*	*Far Advanced.*		
Failure of induction	3	1		2		6
Intrapleural pneumolysis	4		3	3	A.P.	10
Thoracoscopy	1	1				2
Effusion — pleural	1	1	4	2		8
Effusion — peritoneal		1			P.P.	1
Spontaneous pneumothorax				1		1
" Black lobe "			1		A.P.	1
Rapid cavity enlargement		2				2
Scrotal hernia			1			1
Visceroptosis	2		2		P.P.	4
Dyspnœa	1	1		1		3
Acute spread				1	Phrenic crush	1
Abandonment	5	5	2	5	A.P.	17
	2	2	4	1	P.P.	9

Total number of cases treated with pneumoperitoneum 30
Total number of cases treated with pneumothorax 25
Phrenic — crush 23, recrush 5, evulsion 10 — All straightforward operations, except one.

There was no rule as to the alteration or to the coincidence of cavity disappearance and sputum conversion in all the adopted collapse measures.

Pneumoperitoneum contributed to satisfactory results in nearly three-quarters of the cases. This collapse measure was more effective in the treatment of " dorsal " than of " basal " cavities. In cases mostly with " dorsal " cavities, where pneumoperitoneum replaced ineffective pneumothorax treatment, cavity closure followed in half of them. In 8 such failures, 7 cases with " dorsal " and 1 with " basal " cavities, pneumoperitoneum as a sole measure was successful in 4, among which there was 1 case with a " basal " cavity. The majority of the " satisfactory " results was achieved in the first six months of pneumoperitoneum treatment. Cases successfully treated with pneumoperitoneum (quiescence or improvement) have shown a direct relationship to the degree of diaphragmatic ascent. The paralysed hemidiaphragm reached (as observed in April 1949) third anterior rib in 4 cases, third interspace in 4, fourth rib in 6, fourth interspace in 2, fifth rib in 2. No dyspnœa or cardiac embarrassment was observed in any of these cases. No severe hæmoptysis was observed during pneumoperitoneum treatment; in 2 cases repeated profuse hæmoptysis occurred some time after pneumoperitoneum was abandoned.

Failure with pneumoperitoneum treatment was found in little more than one-third—7 cases with " dorsal " and 6 with " basal " cavities. In one such case a large cavity situated in the retrocardiac space disappeared under pneumothorax treatment only after combined pneumoperitoneum was abandoned. Failures with pneumoperitoneum treatment may be attributed to the following: (1) Large cavity (5 by 4·5 cm.) adherent to the chest wall;

(2) thick-walled cavity (in 2 cases); (3) thick-walled cavity with fluid level and a very active process with extensions; the diaphragm not sufficiently raised because of visceroptosis; (4) very active process with extensions despite a lift of the diaphragm to the third anterior rib; (5) massive costo-diaphragmatic adhesions which prevented sufficient rise of the diaphragm; (6) tension cavity (in 3 cases); (7) cavity with a fluid level; (8) well-marked emphysema and extensive fibrosis; (9) large cavity in the retrocardiac space (2 cases). In 4 out of the 13 failures pneumoperitoneum treatment is still being continued, as it might result in cavity closure at a later date. There were only few complications and no serious sequelæ of pneumoperitoneum treatment. Peritoneal effusion was asymptomatic in 1 case, and a satisfactory result was achieved despite its occurrence, which has not been affected by discontinuing. Scrotal hernia has been observed after one year's treatment. It was not associated with any important disturbances, and so it did not contra-indicate continuance of pneumoperitoneum. In 1 case with visceroptosis refills were transitorily painful, but pneumoperitoneum has been continued with satisfactory result. Despite this complication a satisfactory rise of the paralysed diaphragm was obtained in all these cases, except one, with no observable deleterious effects on the patients. The age of 3 patients, who complained of dyspnœa after each refill, was fifty-one, forty-seven and twenty-seven respectively. Two of these patients had well-marked emphysema; in one of them the vital capacity was greatly reduced, due to the emphysema and extensive bilateral lesions. Some discomfort was noticed in 6 patients.

One "dorsal" cavity closed quickly after phrenic paralysis as a sole measure. A remarkable closure of a large "basal" cavity (3·5 by 6 cm.) two years and three months after phrenic evulsion was also observed. However, it is doubtful if the phrenic operation was responsible for this result, as the paralysed diaphragm was not raised owing to massive adhesions. This case had a basal onset.

With one exception pneumothorax treatment of "dorsal" cavities as a sole measure proved a failure, but in "basal" cavities the results were better (3 successful cases, 1 of them with a cavity situated in the retrocardiac space). Pneumothorax was induced in 25 cases for various reasons (in 20 patients as 5 patients had pneumothorax on both sides). Sixteen cases have been treated by artificial pneumothorax because of lower lobe cavities only, and in 11 of them this collapse measure was prematurely abandoned. It was completed in 1 case and maintained in 4. The reasons for abandonment were: (1) Spontaneous pneumothorax; (2) massive atelectasis; (3) rapid enlargement of the cavity following the induction (2 cases); (4) ineffectiveness (5 cases); (5) large pleural effusion (2 cases). Altogether artificial pneumothorax was abandoned in 17 cases.

During pneumothorax treatment pleural effusion formed altogether in 8 cases; in 4 of them tubercle bacilli were found in the fluid. Minimal effusions not associated with any constitutional disturbance and of no clinical importance were not taken into consideration. Induction attempted because of lower lobe cavities failed in more than one-quarter of the cases (4 with "dorsal" and 2 with "basal" cavities). Intrapleural pneumolysis was done in 10 cases (1 partial), and thoracoscopy only in 2. In 1 case even twofold pneumolysis failed to influence the cavity, and pneumothorax was finally abandoned. In

some instances the pneumothorax treatment rendered observation difficult. In very few cases of both " dorsal " and " basal " cavities, artificial pneumothorax, combined with other collapse measures, gave cavity closure.

Spread of the disease was observed in less than a quarter of the cases during collapse treatment. This was noticed with each type of collapse. Apart from one fatal spread after phrenic paralysis, there were no deaths.

It is of interest that 2 patients had no symptoms or history of previous illness, yet a chance X-ray revealed in both of them a large lower lobe cavity. Three cases were nearly asymptomatic, and in 3 others the early symptom was hæmoptysis. Six patients gave a history of an acute onset, imitating in one case typhoid fever and in another dysentery. Of 10 patients with a basal onset of pulmonary tuberculosis the onset was acute in 5 cases, insidious in 4 and symptomless in 1.

Literature and Discussion

A cavity, if not closed, is a serious problem in pulmonary tuberculosis; a lower lobe cavity far more than any cavity in another location. Tuberculous cavities show a predilection for certain parts of the lung. Especially favoured are the peripheral upper regions. Kidd (1886) and Ewart (1889) said that the apex of the lower lobe is a spot only second in point of vulnerability to the apex itself. This is true for typical reinfection tuberculosis. However, reinfection tuberculosis, with an original site of onset in the apex of the lower lobe, is as unusual as it is in the base. It has been suggested that for primarily basal tuberculosis rupture of a caseous tracheobronchial gland into the bronchus is often responsible (Hawkins, 1946). The right lower lobe is more often involved than the left one, for which the right main stem bronchus probably accounts. Extension of a cavity from one lobe into an adjacent one is rare (Goldberg, Jaffe, 1946). Clinical experience shows there is a special tendency to early cavitation of tuberculous pulmonary lesions in the lower lobe. Young people with an exudative type of disease are especially prone. Basal cavities are predilected to stagnation of their bacilliferous secretions. This is particularly true of tension cavities—a comparatively frequent event among lower lobe cavities. Accumulated infected material aggravates the local lesion and favours further breaking down, bronchogenous spread of the disease and general toxæmia. In a patient with profuse secretions and troublesome cough bronchogenous spread, due to a sudden and frequent rise in the intrapulmonar pressure, must be especially feared. Bronchiectasis may coexist. There is also a possibility that a pre-existent bronchiectatic cavity may become secondarily infected with tubercle bacilli (Jaffe).

These dangers demand quick intervention, no matter what the symptoms. It must be borne in mind that the appearance of patients suffering from a peribronchial serocaseous type of pulmonary tuberculosis is very often deceptive. This type of disease produces periodical exacerbations and remissions. In between there may be no complaints and the patients appear to be entirely healthy, many of them even of athletic build (Felix, 1944). If the process affects the lower lobe, the onset is often insidious (Gordon, 1944) without producing symptoms at all. Many authors point out that lesions so situated deteriorate even markedly without manifest symptoms and signs. According to

Pinner (1946), a dramatic subjective improvement and a marked drop in the blood sedimentation rate is not infrequently caused by cavity formation, similar to the general effect of the evacuation of pus from an abscess. However, in cases with basal onset the disease is mostly rapid, of a bronchopneumonic type (Cherry, 1948).

Although spontaneous disappearance of cavities is a fairly frequent event, clinical experience shows that there is little hope that a lower lobe cavity will respond to bed-rest alone. Drainage of stagnated secretions is of great importance, but not sufficient in itself. Respiratory expansion even with complete bed-rest is greater at the bases of the lung than at the apices, and is more frequent in disease than in health. It is still more pronounced in males, where respirations are mostly diaphragmatic. Not all parts of the lower lobe have equal mobility. In front, where the ribs are attached to the sternum, the thoracic cage is more mobile than at the back, near to the vertebral column. Respiratory movements have a traumatising effect on cavities and contribute to their persistence, as cavities are exposed to the constant outwardly directed elastic pull of the lung, which increases with each inspiration. If the pull is removed, the lung retracts and the cavity tends to collapse and may be obliterated. For achieving this effect a selective relaxation collapse and not a compression collapse is often used with success. A relaxation collapse has still more beneficial effects. It brings rest to the diseased tissue. It also prevents an accumulation of secretions. Both factors should prevent intrabronchial spread. In the diseased part of the lung, the blood—and lymph—circulation are rendered difficult with resulting hyperæmia and anoxia which avert hæmatogenes spread and also favour fibrosis so much needed in the shrinkage of a cavity and in the process of repair. Lymph stasis lessens toxæmia. Relaxation collapse makes fuller function after treatment more likely than compression collapse does. In an ideal selective relaxative collapse only the diseased pulmonary tissue, which is more ready to collapse than the normal one, is eliminated from respiration. The healthy parts of the lung are preserved for functioning. This collapse capacity of diseased lung tissue is much more pronounced in the productive than in the exudative type of tuberculosis. Even a minor relaxation collapse may lead to complete obstruction of the draining bronchi, to which event is given the main credit in the closure of cavities. It has been observed that the bronchi in the collapsed part of the lung are in a state of comparative rest and that they are shorter and narrower in both phases of respiration than in the uncollapsed lung. Apart from this, bronchi which drain a tuberculous cavity are often involved in the process, and, as their walls are damaged, they are liable to kink when some relaxation measure is used. There is little probability of suppuration following a bronchial obstruction as according to Coryllos (1936) and Goldman (1941) secondary organisms are found in the larger bronchi only. This mechanism of cavity closure makes possible, however, the reopening of cavities at a later date as the previously occluded draining bronchus may be opened again. Atelectasis, which often accompanies collapse treatment, if not very extensive, can be beneficial to the healing of a tuberculous cavity. Compensatory emphysema and the fibrotic process in the lung play their parts also. But fibrosis never occurs in healthy lung tissue, even when it is collapsed.

Probably no single factor but several of them account at any one time for cavity closure in many instances. If a tuberculous cavity is obliterated by fusion of its walls and scar formation or by conversion into a solid focus, the most frequent form of cavity healing, this is called " closed " healing. In other cases obliteration of the cavity space does not take place, but a non-specific epithelialisation replaces the necrotic lining membrane, and the secretions became free from tubercle bacilli. We speak here of an " open " healing of cavities, a rare event. It is believed that bronchial obstruction with a resulting anoxia and hypercapnia of cavities enhances the disappearance of tubercle bacilli. Despite complete bronchial obstruction, the intracavitary air may not be absorbed by the circulating blood and the cavity remains patent, provided the wall is sufficiently thick and avascular (Bernou, 1947).

Apart from the many advantages of collapse therapy, there are, however, many disadvantages. Collapse treatment must be considered a choice between a greater or a lesser evil. No collapse measure is without its dangers. It produces more functional impairment than healing without collapse. Achieved bronchial obstruction brings cavity closure, but it can also severely aggravate toxæmia. In the same way there are dangers attached to atelectasis in spite of its advantages. This applies also to anoxæmia, which may damage the myocardium, and to many other effects of collapse treatment.

Compensatory emphysema, which helps to replace the destroyed lung tissue, interferes with the collapse of the lung.

The response of tension cavities is unpredictable in every collapse treatment. A minor collapse measure, such as paralysis of the diaphragm, may cause complete block of a partially occluded draining bronchus with resulting cavity closure (Maier, 1945). It rests the draining bronchus and if œdema is the cause of a check-valve mechanism this may subside. Spontaneous healing of such cavities has also been observed. Rothstein (1949) reported three such cases with lower lobe cavities. This author stresses the fact that lower lobe cavities are comparatively often of a tension type. On the other hand, even the most radical surgical procedures may not succeed in closing these cavities, but may even enlarge them. As in many cases tension cavities are caused by tuberculous bronchitis, there is good reason to combine collapse treatment, if this alone is unsuccessful, with streptomycin treatment in such instances.

Another difficulty in treatment is produced by cavities splinted by diseased tissue, especially chronic thick-walled cavities. But a lower lobe cavity is a relatively early feature of tuberculous disease. Busby (1939) points out that such cavities are usually thin-walled, with little or no surrounding infiltration. This feature of lower lobe cavities makes them amenable even to minor relaxation therapy. Such a cavity may close leaving only a fibrous scar. The presence of exudate in a cavity (not a rare occurrence in lower lobe cavities) can help to block the bronchus; but the cavity then becomes inspissated into a solid focus.

Cavities in the apex of the lower lobe are less amenable to collapse treatment than those in the base (Cohen, 1946, Chakar, 1947). The probable explanation is that, when the lung is collapsed, the apex of the lower lobe moves into the paravertebral gutter and escapes compression. Massive paravertebral adhesions, often very short and inoperable, are responsible for unsuccessful collapse treatment in many cases. Big cavities in the apex of the lower lobe, like those

at the extreme apex of the lung, are nearly always adherent to the chest wall (Edwards, 1945). This seldom occurs with basal cavities (Zorini, 1946). The fact that the bronchi near the hilus are big and have rigid walls is less responsible for the poor results obtained in " dorsal " cavities, as these lesions are very often situated far from the hilus.

Because of these important features lower lobe cavities need active treatment without long delay. It is wise to begin with minor relaxation therapy. But in an acute illness with toxæmia, preliminary bed-rest till severe constitutional disturbances abate is reasonable. A short delay of collapse treatment cannot do harm, for the patient who in a brief observation period loses or worsens his chances of recovery by collapse treatment will not benefit by collapse (Pinner, 1946). Treatment with streptomycin causes rapid reduction in toxicity by retarding the growth and multiplication of tubercle bacilli. Used as an initial measure, it may change an otherwise unsuitable case for collapse into a reasonable one. But unfortunately its toxic effects and the risks of streptomycin resistance often require that it should be avoided at this stage. For an acute spread, however, streptomycin treatment may be the only course making subsequent collapse treatment possible.

The criteria for selection of the most suitable type of collapse therapy can be summarised as follows: (1) The greatest probability of its effectiveness; (2) patient's safety (least number of serious complications); (3) the limitation of collapse to the diseased tissue only, as far as this is possible; (4) the greatest likelihood of its reversibility (few lasting consequences of special significance, preservation of fairly good respiratory function of the lung); (5) the possibility of its general use in a very large proportion of suitable cases; (6) simplicity of procedure; (7) good tolerance; (8) time needed for probable cavity closure (because as long as a cavity exists there is a constant danger of spread); (9) the possibility of a good control by X-ray and by physical examinations (important for an early decision on the adopted line of treatment).

Judged by such guiding principles artificial pneumoperitoneum seems to be the most suitable collapse measure for lower lobe cavities. Pneumoperitoneum causes a mechanical rise of the diaphragm, limiting its respiratory movements, lessening its natural tonus, and consequently reducing pulmonary volume. Normally the subdiaphragmatic region, unlike all other parts of the abdomen, has a pressure less than atmospheric, as the intrapleural negative pressure is transmitted to this area. Pneumoperitoneum changes this negative pressure into a positive one with resulting rise of the diaphragm and pulmonary relaxation. Paradoxical movements of a paralysed hemidiaphragm, as seen on fluoroscopy, are not affected by pneumoperitoneum.

Basal pulmonary tuberculosis is often of a bronchopneumonic type with a tendency to early cavity formation. Comparatively early pneumoperitoneum treatment is generally sufficient for collapsing these newly formed thin-walled cavities. Clinical experience has shown that " basal " cavities respond well to this type of collapse (Fowler, 1941; Rilance, 1941, Clifford-Jones, 1943; Steen, 1945; Cohen, 1945; Banyai, 1946). Despite great difficulties in the treatment of " dorsal " cavities, there are reports of their closure by pneumoperitoneum (Lefevre, 1941; Raimondi, 1942; Keers, 1948). Crow (1945), Keers (1948), Trimble (1948), and Moyer (1949) stated that cavitation wher-

ever situated has responded well to pneumoperitoneum if only of recent origin. In this hospital similar observations have been made. Obliteration of interlobar fissures only increases the therapeutic effect of diaphragmatic ascension on the upper lobe. But sometimes, if a cavity is situated below the level of the dome of the diaphragm in the anterior or the posterior sulcus, pneumoperitoneum may be without effect on these parts of the lung, the diaphragm merely shielding the cavity. Also, cavities situated in the retrocardiac space are difficult to treat. In one such case in the present series neither pneumoperitoneum nor pneumoperitoneum combined with a good pneumothorax had any effect. Later on, the pneumoperitoneum was abandoned, and the pneumothorax, as a sole measure, caused disappearance of the cavity and a marked improvement in the patient's general condition.

Large cavities may have a chance of closure if pneumoperitoneum is used. If a large cavity only becomes smaller or a cavity containing fluid becomes dry, it becomes more amenable to subsequent pneumothorax. But it is not so much the size of a cavity itself as the size of the tissue defect which is of real importance. Tension cavities, whatever their size, are worth a pneumoperitoneum trial. Such a minor relaxation measure, as mentioned above, may block the partially occluded bronchus or—reversely—may result in full patency of this bronchus. Tuberculous tracheobronchitis does not contra-indicate this collapse measure, as it does many others.

Closed transpleural drainage, which has here its advocates, can be combined with pneumoperitoneum. The facts that the procedure is bilateral, that it can be combined with nearly all other collapse measures, that it can be quickly discontinued and reinitiated even after a very long interval and changed to a more radical collapse, should the need arise, make pneumoperitoneum still more valuable. The quick lessening of an intractable troublesome cough and relief of pain—symptoms which are due to basal adhesions and irritation of the diaphragm or to chronic basal pleurisy, reduction of toxæmia (facilitated drainage), improvement in general condition (observed also by dyspnœic emphysematous patients)—make pneumoperitoneum a desirable procedure. It is also an important weapon in the checking of severe hæmoptysis.

The results with pneumoperitoneum treatment in the present series are encouraging both for " dorsal " and " basal " cavities. The procedure is safer than any other collapse measure. It was successfully used in very acute types of tuberculosis with pronounced toxæmia (Fremmel, 1937; Mason, 1942; Clifford-Jones, 1943; Steen, 1945; Wade, 1946; Keers, 1948). There is not such a great risk of the rupture of a cavity located near to the surface as there is with a pneumothorax. The serious complications are few. A fatal hæmorrhage into the peritoneal cavity was recorded by Cotton Cornwall (1947). Air embolism, mediastinal emphysema and tuberculous peritonitis are all very rare. The last complication can now be treated with streptomycin, often with good results. It may be attributed rather to the systemic disease than to pneumoperitoneum treatment. Between 1946 and 1949 pneumoperitoneum was induced and maintained in this hospital in 199 cases. No grave complications were observed except in one who developed a fatal tuberculous peritonitis during pneumoperitoneum treatment. Whether pneumoperitoneum may sometimes turn a circumscribed peritonitis into a general peritonitis is

difficult to say. In this hospital one case was seen where appendicectomy revealed tuberculous lesions of the removed appendix, of the mesoappendix and of the adjacent peritoneum (confirmed by pathological examination) with some exudate in the abdomen. After operation, pain in the right side of the abdomen persisted, the patient complained of nausea, ructus, flatulence, constipation, and had subfebrile temperatures. On account of pulmonary lesions with a positive sputum and frequent hæmoptyses a pneumoperitoneum was started. Refills followed every seven days, with 800-1,000 c.c. of air on each occasion. The diaphragm reached the fourth anterior rib on both sides. At present, after eleven months' pneumoperitoneum treatment, which has been carried out smoothly, the patient's general condition has improved markedly, abdominal pain is very rare and not severe, flatulence is lessened, motions are normal, and the patient has become afebrile.

In 3 patients an infective hepatitis developed at the time of pneumoperitoneum treatment. In one of these signs and symptoms of peritonism occurred, probably in connection with massive hepato-diaphragmatic adhesions which formed after infective hepatitis. Shortly before the symptoms of peritonism occurred, the left paralysed hemidiaphragm was at the fourth anterior rib, and the intra-abdominal pressure was +10, +11 cm. of water. This condition subsided soon after cessation of pneumoperitoneum refills. Infective hepatitis can be occasionally responsible for perihepatic adhesions, as in this morbid condition inflammatory changes in the connective tissue are invariably present.

We have also observed nearly all the minor complications which occur in this treatment. In 1 patient with bilateral pneumothorax and pneumoperitoneum, a cavity situated at the base of the left upper lobe disappeared, but reappeared two years later, soon after a paralysis of the right hemidiaphragm (this diaphragmatic leaf was now raised to the fourth anterior rib). Reappearance of the cavity was here possible since the paralysed diaphragm on one side, reinforced by pneumoperitoneum, caused increased compensatory movements of the contra-lateral hemidiaphragm. In comparatively few patients has it seemed advisable to abandon pneumoperitoneum prematurely, although it is much more reversible than any other collapse measure. The technique is easy to perform and can be successfully applied to nearly all patients. The procedure is well tolerated and can be maintained in an ambulatory way. The treatment of an out-patient is easier with pneumoperitoneum than with pneumothorax, as air absorption seems to show less individual differences in the former, and there is not such a danger of space obliteration; it is also safer. Spontaneous rupture of diaphragmatic adhesions during pneumoperitoneum treatment occasionally occurs. It was observed in this hospital; no complications were noticed. If adhesions are not too extensive, they do not interfere with adequate ascension of the diaphragm (Banyai, 1946). Even more extensive adhesions, if they are contra-lateral, may have no bad influence on pneumoperitoneum treatment. Increase of rigidity of the diaphragm in older people interferes with an otherwise successful pneumoperitoneum treatment only in a small proportion of cases. Contra-indications are not numerous; they include myocardial disease (but if this is a result of tuberculous toxæmia it may be reversible), angina pectoris, advanced arterio-

sclerosis, circulatory failure, vital capacity less than 1,500-2,000 c.c. and generalised tuberculosis. It has also been suggested that pneumoperitoneum may not be well tolerated by patients over forty-five years of age (Keers, 1948).

Should pneumoperitoneum be adopted with or without phrenic nerve operation ? Most of the quoted authors have used both measures as a combined procedure. The same line was adopted in the present series, where phrenic surgery was done prior to starting pneumoperitoneum. Phrenic paralysis gives an additional rise to the diaphragm elevated by pneumoperitoneum, and also gives greater stability to it, thus helping in cavity closure. It is felt that in patients with lower lobe cavities pneumoperitoneum treatment by itself is, in general, not sufficient, because here the disease is mostly exudative, so there is little retractile tendency of the affected tissue, and also because of the great mobility of these parts of the lung. However, immobility of the diaphragm may greatly interfere with bronchial drainage with serious sequelæ. It is especially dangerous when bronchiectasis coexists. Concurrent pneumoperitoneum overcomes this obstacle.

Keers (1948) observed cavity closure following contra-lateral phrenic paralysis combined with pneumoperitoneum. Similar observations were made in this hospital. Trimble (1948) found that in most instances the diaphragm became sufficiently elevated after pneumoperitoneum alone, obviating the need for a phrenic operation. This author and his colleagues warn that a phrenic operation is not an entirely innocuous procedure. There are reports of acute bronchogenous spread following a phrenic operation. Deist (1926) described 2 such cases, both fatal; also Dumarest (1928) reported 2 similar cases which terminated fatally. Coenen (1945) noticed 1 and Goldberg (1946) 2 cases with bronchogenic extensions after a phrenic operation. In the present series one fatal spread was seen soon after a phrenic crush. In 1 case a recrudescence of the tuberculous process with cavity formation was noted a few weeks after operation of an olecranal bursa (local anæsthesia). Another case was observed where shortly after appendicectomy a scattered tuberculide occurred (tuberculous granulation was confirmed by biopsy). Edwards and Logan (1945) have described an acute onset of pulmonary tuberculosis after appendicectomy. It is not possible to prove that exacerbation of a tuberculous process is really connected with a procedure previously adopted. But it is a fact that the procedures are carried out on persons with diminished resistance and altered response, which aggravate each intervention.

Phrenic paralysis may be easily obtained in a patient with already maintained pneumoperitoneum, and it is reasonable to do this if a further rise of hemidiaphragm is desirable due to an inefficient pneumoperitoneum. Within two to three weeks, after four to six refills, the need can easily be decided. During this short period the maximum possible relaxation by pneumoperitoneum can be achieved. A compression collapse seems unreasonable; very frequent and large refills may be harmful and may cause only a depression of the abdominal viscera downward and toward the spine, especially if there exists a marked hypotony often found in patients suffering from tuberculosis. Some authors, who prefer to combine pneumoperitoneum with phrenic paralysis, initiate pneumoperitoneum some time prior to phrenic surgery. Such

a " test " procedure enables them to ascertain if an adequate rise of the diaphragm is possible (Crow, 1945). However, Weiss (1947) observed shock in 2 cases with pneumoperitoneum immediately after phrenic paralysis. He urges that a pneumoperitoneum should not be refilled for some time before this operation.

It must be pointed out that some authors, even now, underestimate the value of phrenic paralysis for closing cavities. Since 1911, when Stürtz proposed phrenic paralysis for treatment of serious basal lesions, closure of both " dorsal " and " basal " cavities by such a procedure has been recorded by various authors (Wirth, 1929; Werner, 1930; Kleesattel, 1940; Coenen, 1943; Hasselbach, 1943; Steen, 1945; Cohen, 1945; Zech, 1947; Seidel, 1948; Ohlig, 1948; Dambrin, 1948). Clinical experience confirms the view of Hein (1938), Hasselbach (1943), Seidel (1948), and other authors that phrenic paralysis is an absolute indication in the treatment of " dorsal " cavities. The discrepancy between the comparatively insignificant degree of collapse achieved by phrenic paralysis and the good results in cavity closure Sturm (1947) tries to explain by the fact that the phrenic nerve is not only a motor but also a vegetative nerve. Vaccarezza (1948) points out that the phrenic nerve has connections with the cervical sympathetic and the solar plexus, and that it contains non-myelinated fibres. It is suggested that these fibres supply mostly the middle and perihilar zones of the lung. If this is really so, the comparatively good response of lesions situated in these zones to phrenic nerve operation may perhaps be due to it.

Which type of phrenic operation is more advisable should the need arise—a temporary or a permanent one? A temporary procedure is less dangerous. By evulsion damage to the blood vessels, the thoracic duct, the sympathetic or vagus nerve becomes more likely. A temporary measure does not interfere permanently with other possible collapse procedures in the future, should that be thought desirable. As the lungs possess a large functional reserve, even a considerable reduction of pulmonary function by phrenic paralysis has no ill effects. Diaphragmatic paralysis contributes to impairment of the cardiopulmonary reserve, but in most cases with lower lobe cavities the disease is not long standing, " cor pulmonale " should not be feared and a temporary phrenic nerve operation is generally unlikely to bring any harm. Phrenic evulsion, however, may become troublesome later when the patient is older. If there is a history of pleural effusion one must be very careful with diaphragmatic paralysis as the lung function may be grossly impaired by the fusion of both pleural layers. Unfortunately, this condition often escapes radiological observation. So-called temporary phrenic paralysis becomes permanent in about 10 per cent. of cases, even if the nerve has been handled gently. By a second operation the figures are nearly doubled (Hardy, 1948). The effect of crushing lasts approximately six to twelve months, and may call for recrush without delay. Such procedure can be repeated again and again; however, as O'Brien points out, every next recrush is less effective. In this hospital unsuccessful phrenic operations comprised a large number of recrushes. Accessory phrenic nerves, which may come to hyperfunction during a temporary paralysis of the phrenic nerve, are probably responsible in some of these cases. In most of the cases in the present series temporary paralysis of the

diaphragm followed by pneumoperitoneum offered good results in the treatment of lower lobe cavities. Only in 5 cases out of 23 regaining of normal mobility of the temporarily paralysed hemidiaphragm called for recrush. This is so because an exudative process (frequent occurrence with lower lobe lesions) responds to collapse treatment in a quicker way than a productive one. The avoidance of recrushes is also caused by the fact that a diaphragm which has regained its usual mobility is still raised, probably due to partial atonicity. This protracted rise of the diaphragm is still more pronounced if a phrenic procedure is combined with pneumoperitoneum treatment; a prolonged stretching of the muscle fibres may be the cause.

According to Hoffman (1949), when an early combined use of pneumoperitoneum and streptomycin was used, cavity closure rate was almost doubled in comparison to pneumoperitoneum alone. Apart from that such a procedure diminishes the number of contra-indications to pneumoperitoneum treatment.

Artificial pneumothorax is a comparatively old procedure, and the clinical experience is large. The great value of pneumothorax treatment is generally accepted. Edwards (1945) wrote: "We do not see any probability of pneumoperitoneum replacing the more perfect collapse of a good pneumothorax as the primary weapon for any type of disease." And again Keers (1948): "An effective and uncomplicated pneumothorax remains the best of all forms of collapse, and even the most sensational diaphragmatic elevation does not constitute an adequate substitute."

Unfortunately, in cases with lower lobe cavities, a good uncomplicated pneumothorax is a rarity. The greatest obstacle in this type of collapse is the presence of pleural adhesions, which form usually around the lesions. They frequently keep open lower lobe cavities, both "dorsal" and "basal." Hebraud (1946) points out that often no adhesions can be seen at the diseased apex of the lower lobe on the X-ray, but nevertheless thoracoscopy reveals many of them. A peripherally situated cavity (the usual location) lying at the base of an adhesion is a potent source of danger. Adhesions associated with lower lobe cavities are often inoperable owing to their extensiveness, small size, or to their interlobar situation. Less commonly the lung may be firmly adherent to the lateral chest wall or to the diaphragm. There are many other points which make intrapleural pneumolysis impossible or contra-indicate it. Partial pneumonolysis is mostly ineffective and dangerous. Sometimes it happens that after division of a number of pleural adhesions more of them become visible, which are inoperable. All this intervenes with the induction of a good pneumothorax or with its maintenance. Pleural adhesions if, fortunately, not present from the start of the pneumothorax treatment often develop later. They are the sequel of fluid which forms in the pneumothorax space in most cases. Because of this fluid, additional temporary phrenic paralysis may become a permanent one (Seidel, 1948). The forming of costo-diaphragmatic adhesions may render a subsequent pneumoperitoneum treatment difficult. Apart from that, pneumothorax causes atelectasis much more frequently than any other collapse measure, thus augmenting the rhythmical inspiratory pull of the lung. To pneumothorax treatment are attached many complications, some of them grave in their potency; lasting consequences are much more numerous than with pneumoperitoneum, and their dimensions cannot be

foreseen at the start of the treatment; the technique of selective hypotensive pneumothorax is more precise than in the past, when it was customary to compress the lung; pneumothorax once abandoned can comparatively seldom be reinitiated; control by X-ray and by physical examination is often difficult; the duration of treatment is not shorter than with a pneumoperitoneum, and the effectiveness of this type of collapse in lower lobe cavities is less favourable than of pneumoperitoneum combined with phrenic paralysis, one reason being that diaphragmatic movements are preserved and vigorous as seen on screening. Clinical observation has brought Cohen (1946) to the conclusion that for "basal" cavities pneumoperitoneum preceded by a phrenic crush is the best initial treatment. This author holds pneumothorax in reserve for those "basal" cavities which do not show signs of closure after two months' pneumoperitoneum treatment. Hawkins (1946) reported 13 cases with a basal cavity, treated by pneumoperitoneum and phrenic paralysis. In these cavity closure was achieved in 12 (primarily basal tuberculosis).

Many authors have recommended the combination of pneumothorax and phrenic paralysis in "basal" lesions as pneumothorax alone is unsatisfactory. Where the base of the lung is free from adhesions pneumothorax may, to some degree, release the lung from the pull of the diaphragm, but pneumoperitoneum does it much more effectively. If the lung is fixed by basal pleural adhesions or is even solidly adherent to the diaphragm, it is obvious that pneumothorax cannot be effective, but the elevation and the stability of the diaphragm relieves tension and may promote cavity closure. Of a total of 72 patients with "basal" lesions treated by pneumothorax alone, and reported by various authors, satisfactory results were obtained in 32 (Steen). Steen (1945) also pointed out that when cavitation occurred the results were not so good. Many authors have observed that the proportion of successful pneumothorax cases with "dorsal" cavities is lower than with "basal" cavities. Behrendt (1948) reported 33 cases treated because of "parahilar" cavities; 28 of them were "dorsal." Of 21 cases treated with pneumothorax, cavity closure was observed only in 8. Rothstein (1949) used pneumothorax on the side of the lower lobe lesion in 16 patients. The results were bad in every case. This author considers pneumothorax contra-indicated for such lesions. It is significant that of 22 cases with "dorsal" cavities reported by Hasselbach (1943) to be treated with a phrenic operation, as many as 20 were successful. Hasselbach (1943), Chakar (1947), Seidel (1948) and Ohlig (1948) emphasise that pneumothorax should be avoided in the treatment of "dorsal" cavities. The last two even write about the hindering effect of pneumothorax upon treatment with paralysis of the diaphragm. On several occasions cavity closure followed pneumothorax abandonment after combined treatment by pneumothorax and phrenic paralysis had failed. In 1 case cavity closure was achieved only after the residual pneumothorax space was obliterated following talc introduction. The authors suggest that paralysis of the diaphragm causes upwards displacement of the lower lobe along a fixed hilus which kinks the "dorsal lobe" bronchus. Pneumothorax cannot do this, and may prevent it after diaphragmatic ascension. The anatomy of the "dorsal lobe" bronchus may well account for the paradox. It passes from the hilus directly backwards as a short stem, and the horizontal situation of this bronchus makes its kinking

by pneumothorax impossible. However, the main stem ends by dividing into three branches, superior, paravertebral and axillary (Brock, 1945). They pass backwards, but in addition the superior branch runs upwards, the paravertebral branch slightly medially and downwards, and the axillary branch downwards and laterally. There is some variation in the direction and extension of these bronchi. It seems logical that kinking of the " dorsal lobe " bronchus by various collapse measures, resulting in cavity closure, depends on the branch draining the cavity, the position and size of this bronchus, and whether more than one may be involved. Pneumothorax may in one case impede the effect of a phrenic nerve operation, whereas in another it can help. As cavity closure also depends on other factors than occlusion of bronchocavitary communications, there is something unpredictable about successful phrenic paralysis, pneumothorax or the combined procedure. In the present series the best results both in " dorsal " and in " basal " cavities were achieved by pneumoperitoneum. But each collapse measure, separately or in combination, was occasionally successful. Recently Crofton (1949) reported good results with pneumothorax in " dorsal " cavities, but the author gave no comparative figures of cases with pneumoperitoneum treatment.

A lower lobe cavity, if peripheral and large, cannot be treated by pneumothorax as its walls are often thin and favour rupture. If it is medial, it is as resistant to pneumothorax as to any other collapse measure. Tension cavities are not suitable for pneumothorax treatment, as they may increase rapidly in size, even alarmingly, with imminent danger of rupture. A tension cavity may not be suspected even after pneumothorax induction. Simmonds (1941) drew attention to a group of pneumothorax cases where the cavity increased in size only after adhesions were divided and the affected part of the lung completely freed. Tracheobronchial tuberculosis contra-indicates pneumothorax treatment, as it greatly interferes with bronchial drainage, causes extensive atelectases, and may result in irreversible pulmonary collapse. Routine bronchoscopy, before pneumothorax induction, might consequently reduce the number of pneumothorax cases. Finally it must be borne in mind that reactivation of silent contra-lateral lesions is more likely by pneumothorax than by pneumoperitoneum.

The value of extrapleural pneumothorax for lesions not amenable to ordinary intrapleural pneumothorax is still questionable. For lower lobe cavities Zorzoli (1946) advocated selective basal extrapleural pneumothorax. Complete separation of the diaphragmatic pleura from the diaphragm is often impossible, but it is sufficient to free the diaphragm from costo-diaphragmatic adhesions. The parietal pleura is stripped off the chest wall along the plane of the endothoracic fascia only in its lower part. Meunier (quoted by Chatard, 1948) advocated separation of the interlobar fissure as far as possible in these cases. Zorzoli reported comparatively good results in 15 cases treated by basal extrapleural pneumothorax. He pointed out that lower lobe lesions, though peripherally situated, are mostly not cortical, which makes stripping possible. This limited procedure of basal extrapleural pneumothorax had few complications. It was used in subacute exudative and progressive types of disease. The extrapleural space was more resistant to tuberculous infection than an intrapleural one (L'Eltore, 1946; Schmidt, 1948). If hæmorrhage or infection

do not interfere with operative results, the artificial cavity is covered by mesothelial cells in four to six weeks, and imitates an intrapleural cavity (Berlinger, quoted by Naegeli, 1948). New advances in treatment (sulphonamides, penicillin, streptomycin, para-aminosalicylic acid) also increase its relative safety. The procedure gives a selective collapse. Because of the positive pressure in the extrapleural space the lung excursion is negligible. Zorini (1946) recommended the combination of this collapse measure with paralysis of the diaphragm. Thompson (1942) advocated extrapleural pneumothorax for " dorsal " cavities only if they were thin-walled and where their diameter did not exceed 3 cm. Friedman (1949) emphasised that cavities so situated were frequently benefited by this form of therapy even when 4·5 cm. in diameter, since they were more accessible to direct collapse. Le Foyer (1949) used this procedure for " basal " cavities with success. According to Le Foyer, the decision whether a basal or a total extrapleural pneumothorax should be done for " basal " cavities depends on the size of the cavity, on the state of the homolateral upper lobe and contralateral lung, and on the activity of the disease. Schmidt (1948) used extrapleural pneumothorax for " basal " cavities when phrenic evulsion was ineffective. He described one case with a large cavity in the posterior costo-diaphragmatic angle where even extrapleural pneumothorax with an extensive pleural stripping was unsuccessful, but the addition of a phrenic evulsion closed the cavity. According to Zorini (1946), even large cavities, if only " basal," can be successfully treated with extrapleural pneumothorax. Thick-walled cavities, however, tend to be displaced towards the mediastinum without any effect on their size. L'Eltore (1946) reported an example of a " parahilar " cavity where artificial pneumothorax and phrenic evulsion were both ineffective, but additional homolateral extrapleural pneumothorax proved satisfactory (" pneumothorax mixte "). Such a procedure was advocated by Valli (1946) for cases with lower lobe cavities complicated by apical and paravertebral symphysis, and not amenable to phrenic evulsion. One case with a large " dorsal " cavity (4·5 by 3·5 cm.) in the present series was successfully treated with extrapleural pneumothorax in conjunction with pneumoperitoneum. Unexpandable lung, previously so feared, does not occur even after three to five years of extrapleural pneumothorax treatment, providing a proper technique is used (Brunner, quoted by Naegeli, 1948), but, of course, proper care after operation is essential. Subsequent thoracoplasty is only seldom necessary. Although extrapleural pneumothorax is still unpopular it should be considered in cases with lower lobe cavities, where thoracoplasty is to be avoided.

Plombage, in any form, should be avoided because basal disease is mostly exudative, and because its cavities are peripheral. Closed transpleural drainage has become less and less popular. It succeeds only in a very small proportion of cases with permanent cavity closure. It is still less popular in lower lobe cavities, as in most of them it only reduces the size of the cavity which must be finally treated by thoracoplasty.

Cavernostomy is rejected by many modern authors. O'Brien (1947) reported satisfactory results after previous failure of the usual methods of collapse therapy. Of 8 patients with large lower lobe cavities, unclosed by pneumothorax or phrenic paralysis, 5 achieved arrested disease and 1 was

improved. Rothstein (1949) reported 2 cases with lower lobe cavities where cavernostomies were done plus streptomycin; both were satisfactory, though in one phrenic crush and pneumoperitoneum were done as well. Chadourne (1949) is one of the advocates of this procedure when relaxation measures have failed. Usually the peripheral situation of cavities makes this operation a comparatively easy one.

A selective lower thoracoplasty is inefficient and a total thoracoplasty, used for lower lobe lesions, puts the whole healthy upper part of the lung out of action. Even after a total thoracoplasty the results in terms of cavity closure for both " dorsal " and " basal " cavities, whether of a tension type or not, are not striking. The same difficulties met by any collapse measure when dealing with " dorsal " cavities are found also with thoracoplasty, where similarly the lung evades complete relaxation by sinking into the paravertebral gutter (Judd, 1944). Maurer's thoracoplasty (quoted by Weber, 1946) tried to overcome this difficulty. Large lower lobe cavities are also not amenable to thoracoplasty. Phrenic interruption supplementing thoracoplasty is inadvisable owing to the attendant complications. Revision procedure is here uncertain in its effect. Moreover, usually a progressive exudative type of disease, fear of aspiration infection following operation, possible coexistence of bronchiectasis, difficulties in assessing cavity closure, all greatly restrict application of thoracoplasty to lower lobe cavities. However, an unexpandable lung after pneumothorax therapy will necessitate thoracoplasty. When a lower lobe cavity coexists with other lesions in the homolateral upper lobe and minor relaxation measures fail, thoracoplasty is justified, provided there are no absolute contra-indications. In this series one patient with a " dorsal " and one with a " basal " cavity were treated by seven- and ten-rib thoracoplasties respectively, both successfully.

If all other collapse measures fail, lung resection is the only procedure left open. Lower lobe cavities more often indicate this procedure than those elsewhere, especially if they are under tension, associated with bronchostenosis, are resistant thick-walled and fibrotic or accompanied by extensive lesions confined to one lobe, heavy secondary suppurative infection, or co-existing bronchiectasis. Basal cavities are suitable for lobectomy only if the state of the lung permits and the larger bronchi are not involved. Pneumoperitoneum supported by phrenic paralysis is often adequate to obliterate the dead space and should be maintained till the residual lobe expands sufficiently to fill the space deficiency (compensatory emphysema). For " dorsal " cavities, as the fissure is very often fused, a pneumonectomy is often required. It should be followed by thoracoplasty (Sellors, 1949). Improved technique is now lowering the number of complications and the operative mortality.

Streptomycin can be used additionally to each of the treatments described above. It is of value in lesions of recent development, as it decreases caseation and promotes fibrosis. Because of its beneficial influence on the surrounding lung tissue, streptomycin may be very useful in the treatment of cavities if the lung process is mostly of an exudative type. As draining bronchi are mostly involved, the curative action of streptomycin on bronchial tuberculosis is of great importance in achieving cavity closure. When streptomycin is administered intramuscularly every four hours in a total daily dose of 1·8 to

2·0 gm. the average concentrations in large tuberculous cavities are much greater than those which completely inhibit the growth of tubercle bacilli *in vitro* (Steenken, 1947). Unfortunately, this is usually a toxic dose. Smaller doses are, however, ineffective since the streptomycin reaches the cavity with difficulty because of its poor vascularity. On present knowledge, there is little possibility that streptomycin treatment can, to any extent in the future, replace standard collapse therapy. On the contrary, it strengthens the position of these procedures, increasing the number of reasonable cases for collapse treatment and the efficiency of the procedure, being effective in many complications attached to collapse therapy. Although tuberculous cavities can often be closed with streptomycin treatment, they often reappear. For maintaining cavity closure Hoffman (1949) recommends the induction of pneumoperitoneum before the streptomycin is discontinued. According to this author the decreased circulation in the relaxed lung does not interfere with successful streptomycin treatment. It seems that systemic and local use of streptomycin, at one time reinforced by a simultaneous collapse therapy, may considerably reduce not only the dosage but also the duration of the antibiotic treatment. The former lessens the toxic effects; the latter is most important in preventing the tubercle bacilli from becoming streptomycin-resistant.

In the series presented in this paper one case with two tension cavities, one of which was " basal," did not respond to pneumoperitoneum as a sole measure, but streptomycin in conjunction with pneumoperitoneum resulted after two months' treatment in the disappearance of both cavities in X-ray and in sputum conversion. In another case a course of streptomycin for tracheobronchial tuberculosis decreased the amount of sputum and improved the patient's general condition, but had no effect on the cavity itself. If many ways of treatment are available without an undue delay, most of the regenerative power and physiological reserve may be saved in each case (*e.g.*, avoidance of cardiac failure, nutritional failure, amyloidosis, non-pulmonary tuberculosis, etc.). This may lead to an increased rate of cavity closure.

Summary

The use of pneumoperitoneum as an initial and early treatment of lower lobe cavities is reviewed. It is felt to be of value, especially in conjunction with phrenic paralysis, judging from the relevant literature, and results obtained with a short series of 43 patients treated by various collapse measures. Results are given for consecutive cases with lower lobe cavities admitted between January 1945 and October 1948. There were 26 " moderately advanced " and 17 " far advanced " cases. They were observed for periods of six months to three years and four months. The results were as follows: 24 were satisfactory in regard to cavity closure and sputum conversion, 4 improved and 15 were unsatisfactory—*i.e.*, unimproved, deteriorated, or dead (2 cases). Pneumoperitoneum contributed to satisfactory results in 16 cases. Illustrative case reports are given in the appendix.

The pathology of lower lobe cavities, dealing separately with " dorsal " and " basal " cavities, is discussed.

The advantages and disadvantages of various collapse procedures and of lung resection in the management of lower lobe cavities are analysed.

APPENDIX

Illustrative Cases

CASE 1.—F. O. Male. Aged 24. Acute onset February 1947 with temperature 100°-101°F., intractable cough, pain in left chest, night sweating. Admitted to hospital soon after. General condition poor. Toxic. Weight 9 st. 12 lb. T.B. Positive. B.S.R. 63 mm., 74 mm. (Westergren, first and second hour). X-ray: infiltration left mid zone, with cavity. Upper zones clear. Bed-rest. Afebrile for four months. During this period put on weight, T.B. consistently Negative, B.S.R. dropped, cavity disappeared in X-ray. August 1947 temperature again 100°-101°F., troublesome productive cough, T.B. Positive. X-ray: (Figs. 1a and 1b) infiltration left mid zone, with " dorsal " cavity (2·5 cm. in diameter). Left phrenic crush and pneumoperitoneum October 1947. October 1948 transferred to Convalescent Home. Excellent general condition. Afebrile. Weight 10 st. 2 lb. T.B. Negative consistently during previous eight months. B.S.R. 5 mm., 17 mm. Pneumoperitoneum still being continued. X-ray: (Figs. 1c and 1d) left hemidiaphragm at fourth anterior interspace. Cavity not apparent for nine consecutive months, cavity closure confirmed by tomograms. *Comment.*—Basal onset. " Dorsal " cavity closed after three months' bed-rest only, but reopened four months later. After five months of combined treatment of phrenic paralysis and pneumoperitoneum, cavity closed again.

CASE 2.—S. A. Male. Aged 37. Past history: more or less productive cough, night sweating and increasing weakness for two months. Admitted July 1947. Weight 9 st. 10 lb. T.B. Positive. B.S.R. 47 mm., 82 mm. X-ray: (Fig. 2a) left " dorsal " cavity (2·5 by 2 cm.) and infiltration at the base of right upper lobe. Left phrenic crush and pneumoperitoneum December 1947. May 1949 good general condition. Weight 10 st. 3 lb. T.B. Negative consistently for thirteen months. B.S.R. 12 mm., 30 mm. Pneumoperitoneum still being continued. X-ray: (Fig. 2b) massive hepato-diaphragmatic adhesions. Adequate rise of left hemidiaphragm (fourth anterior rib). No evidence of cavity for sixteen months. In its place density (fibrosis ?). Infiltration in right upper lobe still present. *Comment.*—Phrenic paralysis with pneumoperitoneum caused prompt closure of a " dorsal " cavity. During the treatment massive hepato-diaphragmatic adhesions have formed which do not prevent an adequate lift of the contra-lateral hemidiaphragm.

CASE 3.—M. J. Male. Aged 25. Past history: acute onset July 1946, with temperature 101°-102°F., productive cough, pain in chest and sweating. Admitted to hospital soon after. Weight 9 st. 8 lb. T.B. Positive. B.S.R. 35 mm., 47 mm. X-ray: extensive infiltration right lower zone with large " basal " cavity, scattered foci in upper zones on both sides. Right pneumothorax August 1946 (patient afebrile). X-ray: (Fig. 3a) right lung well collapsed, infiltration and atelectasis right lower lobe, with large cavity (4 by 5 cm.), some right pleural effusion. Laryngeal lesion May 1947. Febrile. Persistently T.B. Positive. X-ray: " basal " cavity unchanged. Pneumothorax abandoned. Right phrenic crush and pneumoperitoneum July 1947. May 1949 excellent general condition. Afebrile. Weight 11 st. 3 lb. T.B. Negative consistently for sixteen months. B.S.R. 3 mm., 5 mm. Larynx healed. Pneumoperitoneum still being continued. X-ray: (Fig. 3b) right hemidiaphragm at fifth anterior rib. Moderate visceroptosis. Small area of atelectasis right lower zone. No evidence of cavity for twenty months, cavity closure confirmed by tomograms. *Comment.*—Pneumothorax caused extensive atelectasis, but did not influence the cavity, and the process remained active. After five months of combined treatment of pneumoperitoneum and phrenic paralysis cavity closure followed, with disappearance of all toxic symptoms. Visceroptosis did not adversely affect the result.

CASE 4.—N. A. Male. Aged 18. Past history: intractable cough, pain in chest, subfebrile temperatures for three months. Admitted July 1948. Weight 12 st. 1 lb. T.B. Positive. B.S.R. 29 mm., 59 mm. X-ray: cavity in right upper zone, 3 cm. in diameter. Another large cavity (6 by 4 cm.) in left lower zone, in retrocardial space. Left phrenic crush and pneumoperitoneum August 1948. Left pneumothorax added September 1948. Right phrenic crush February 1949. March 1949 general condition deteriorating steadily. Periodically subfebrile. Weight 11 st. 4 lb. T.B. persistently Positive. B.S.R. 20 mm., 39 mm. X-ray (Figs. 4a and 4b) pneumoperitoneum; left hemidiaphragm: third anterior interspace. Left pneumothorax: lung well collapsed. Both cavities unchanged. Pneumoperitoneum abandoned. June 1949 improved general condition. Afebrile. Weight 10 st. 2 lb. T.B. Positive. B.S.R. 10 mm., 24 mm. Pneumothorax only. X-ray (Figs. 4c and 4d) good left pneumothorax with little fluid in costo-diaphragmatic angle. Left hemidiaphragm: sixth anterior rib (regained its mobility). The left-sided cavity not visible. In its place density. The right-sided cavity unchanged. *Comment.*—Pneumoperitoneum with a high diaphragmatic ascension in conjunction with good pneumothorax (which was induced on a later date) did not affect very large " basal " cavity in retrocardial space, after seven months of such treatment (this cavity was

PLATE IX

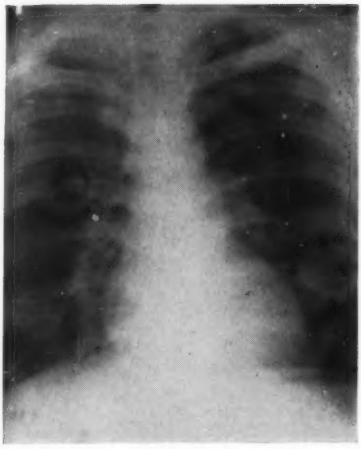

FIG. 1a

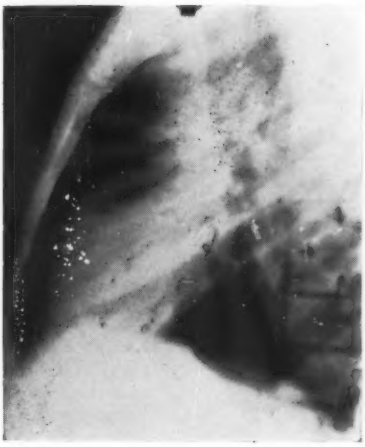

FIG. 1b

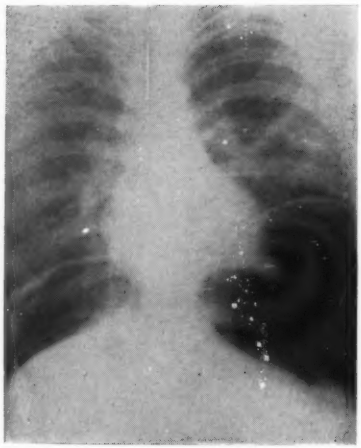

FIG. 1c

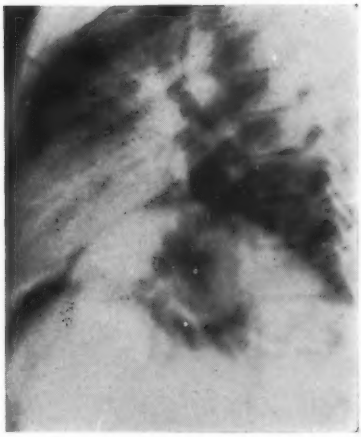

FIG. 1d

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PLATE X

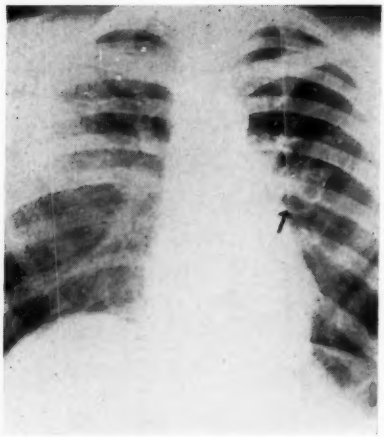

FIG. 2a

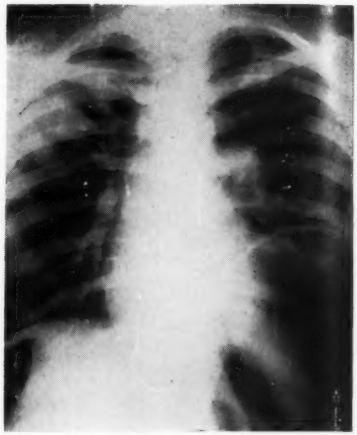

FIG. 2b

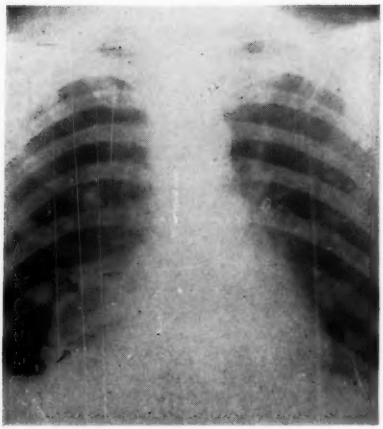

FIG. 3a

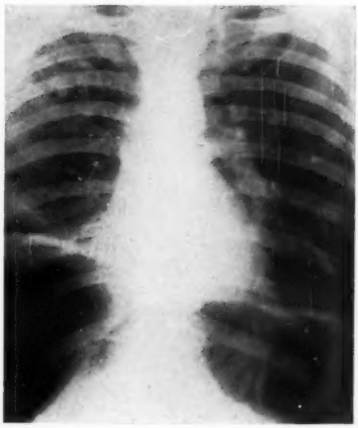

FIG. 3b

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almost completely hidden behind the heart silhouette in a postero-anterior film, but is well demonstrable in an oblique and in a lateral view). After pneumoperitoneum had been abandoned the cavity disappeared.

CASE 5.—J. W. Male. Aged 37. Past history: intractable cough, lassitude, pain in chest, subfebrile temperatures for eight months. Admitted September 1947. Weight 11 st. 3 lb. T.B. Positive. B.S.R. 2 mm., 8 mm. X-ray: left "dorsal" cavity (4·5 by 3·5 cm.) with basal fluid level; tension cavity. Small scattered foci in right lung. Left phrenic crush and pneumoperitoneum (October 1947) without any effect after one and half years of such a treatment; left hemidiaphragm at fourth anterior rib. Left pneumothorax attempt failed. Pneumoperitoneum abandoned and extrapleural pneumothorax instituted June 1948 (without apicolysis and without any separation from the diaphragm). T.B. Positive, small cavity in left third anterior interspace still visible after the operation. Pneumoperitoneum reinduced July 1948 (left hemidiaphragm regained already its mobility). May 1949, good general condition. Afebrile. Weight 11 st. T.B. Negative consistently for eight months. B.S.R. 2 mm., 4 mm. Pressures of about plus 20 cm. of water being maintained in the extrapleural space and pneumoperitoneum continued. X-ray: left hemidiaphragm at fourth anterior interspace, cavity not visible (for eight months). *Comment.*—Pneumoperitoneum combined with phrenic paralysis ineffective. Extrapleural pneumothorax quite straightforward, and caused marked cavity shrinkage. Additional pneumoperitoneum treatment (without diaphragmatic paralysis) resulted in complete cavity closure after six weeks of this combined procedure.

CASE 6.—N. E. Male. Aged 27. Past history: anorexia, asomnia, dry cough, fatigability for two months. Admitted January 1946. Subfebrile. Weight 9 st. 4 lb. T.B. Positive. B.S.R. 16 mm., 40 mm. X-ray: infiltration right mid zone, with cavity, and infiltration with cavitation left upper zone. Right pneumothorax March 1946. "Dorsal" cavity, which enlarged considerably. Pneumothorax (with effusion) maintained three months only. Pleural effusion absorbed spontaneously. Right phrenic evulsion July 1946. X-ray: right "dorsal" cavity (3·5 by 3 cm.), and another cavity under left clavicle. Right hemidiaphragm raised to fifth anterior rib. Right lung nearly completely re-expanded. Pleural effusion on the right up to fifth anterior interspace. Soon after phrenic evulsion "dorsal" cavity no more apparent. Left pneumothorax August 1946. Left pleural effusion formed. Pneumothorax ineffective and abandoned. Pneumoperitoneum April 1947. May 1949 good general condition. Afebrile. Weight 8 st. 4 lb. T.B. Negative consistently for seven months. B.S.R. 4 mm., 14 mm. Pneumoperitoneum still being continued. X-ray: left costodiaphragmatic adhesions. Considerable rise of right hemidiaphragm (third anterior interspace). The right sided cavity had contracted to linear striation. Cavities closed both sides, confirmed by tomograms. *Comment.*—Phrenic evulsion caused quick closure of a "dorsal" tension cavity. Pneumoperitoneum gave an additional rise of the hemidiaphragm and maintained this effect. Right pneumothorax enlarged tension cavity and caused pleural effusion. Left pneumothorax caused also pleural effusion, with a subsequent formation of costo-diaphragmatic adhesions. These adhesions did not have a bad influence on the satisfactory ascension of the contra-lateral hemidiaphragm, but they rendered the rise of the homo-lateral leaf impossible. Left-sided cavity closed spontaneously.

CASE 7.—B. B. Male. Aged 43. Hæmoptysis March 1946. Admitted to hospital soon after. Weight 10 st. T.B. Positive. B.S.R. 18 mm., 45 mm. X-ray: right "dorsal" cavity with basal fluid level (4 by 4 cm.). Infiltration left upper zone, with cavity. Right pneumothorax May 1946. Tension cavity. Pneumothorax ineffective and quickly abandoned. Laryngeal lesions. Right phrenic evulsion July 1946 and left pneumothorax (refills terminated in October 1948). Right hemidiaphragm raised to fourth anterior interspace. "Dorsal" cavity unaffected seven months after the phrenic operation. Pneumoperitoneum February 1947, discontinued January 1948 because asymptomatic abdominal effusion formed. April 1949 transferred to Convalescent Home. Good general condition. Weight 13 st. T.B. Negative consistently for sixteen months. B.S.R. 8 mm., 14 mm. X-ray: right hemidiaphragm at third anterior interspace. Cavity on the right not visible for twenty-two months, had contracted to linear striation. Cavity on the left not apparent for twenty-four months, closure confirmed by tomograms. Larynx healed. *Comment.*—Pneumothorax and later phrenic evulsion ineffective in a "dorsal" cavity of a tension type. After nine months of combined treatment of phrenic paralysis and pneumoperitoneum, with an additional raise of the diaphragm, cavity closure followed. During pneumoperitoneum treatment abdominal effusion formed which was absorbed spontaneously after cessation of refills and was of no consequence. Pneumoperitoneum treatment was abandoned after eleven months, and fifteen months later the result is unchanged—*i.e.*, satisfactory. The paralysed hemidiaphragm remains at a higher level than it was before pneumoperitoneum treatment.

CASE 8.—S. J. Male. Aged 32. Completely symptomless. Admitted March 1947. Weight

11 st. T.B. Positive. B.S.R. 11 mm., 18 mm. X-ray: infiltration right lower and mid zones, with " basal " cavity (4 cm. in diameter), also small dense scattered foci in both lungs. Right phrenic crush and pneumoperitoneum May 1947. May 1949 excellent general condition. Weight 12 st. 2 lb. T.B. Negative consistently for one and half years. B.S.R. 4 mm., 7 mm. Right scrotal hernia diagnosed one year previously. Pneumoperitoneum still being continued. X-ray: right hemidiaphragm at fourth anterior rib (but regained its mobility nine months before). The lesion has become atelectatic with disappearance of the cavity in X-ray, cavity closure confirmed by tomograms. Scattered foci unchanged. *Comment.*—Phrenic crush reinforced by pneumoperitoneum accounted for closure of a large " basal " cavity after four months of such treatment. Adequate rise of the previously paralysed hemidiaphragm is still maintained despite its regained mobility. After one year of pneumoperitoneum treatment scrotal hernia occurred which gives negligible disturbances, and this collapse measure is still continued.

Case 9.—B. M. Male. Aged 48. Hæmoptysis March 1944. T.B. Positive. X-ray: infiltration left upper zone, with cavity. Right lung clear. Left thoracoplasty of four ribs January 1945. X-ray: spread, with a new left " basal " cavity (3 by 2·5 cm.). Left phrenic evulsion and pneumoperitoneum July 1946. Revision thoracoplasty April 1947. April 1949 good general condition. Weight 11 st. 2 lb., steady for more than half a year. T. B. Negative consistently for twenty-one months. B.S.R. 15 mm., 34 mm. Pneumoperitoneum still being continued. X-ray: adequate rise of left hemidiaphragm. Cavity definitely not apparent for fifteen months, closure of cavity confirmed by tomograms. *Comment.*—After one to one and half years' treatment with phrenic paralysis and pneumoperitoneum " basal " cavity closed in an individual with ipsolateral thoracoplasty. Revision thoracoplasty closed another cavity in the upper zone.

Case 10.—S. K. Male. Aged 30. Past history: troublesome cough, pain in chest, fatigue for some months. Admitted February 1945. Temperature 99°-102°F. Weight 9 st. 12 lb. T.B. Positive. B.S.R. 40 mm., 65 mm. X-ray: infiltration in right mid and lower zones, with large basal cavity (3·5 by 6 cm.) Infiltration also left mid zone, with cavity formation. Both upper zones clear. Left pneumothorax July 1945. Right phrenic evulsion December 1945. Because of diaphragmatic adhesions no ascension of the diaphragm. Patient unco-operative. Pneumothorax abandoned January 1947. Since then conservative treatment. May 1949 good general condition. Persistently afebrile. Weight 11 st. 4 lb. T.B. Negative consistently for thirteen months. B.S.R. 31 mm., 62 mm. X-ray: right hemidiaphragm sixth anterior rib. Atelectasis and fibrosis right lower zone. No cavity visible on either side for twenty-one months (left cavitation disappeared earlier, during lung re-expansion after pneumothorax was discontinued). Well-defined nodular and linear shadows in both lungs. *Comment.*—Basal onset. According to cavity disappearance in X-ray and persistent sputum conversion to negative, it must be assumed that closure of a large " basal " cavity followed after two years and three months from phrenic evulsion. It is questionable whether the procedure really contributed to this effect, as the diaphragm did not raise at all because of numerous adhesions and was immobile already before phrenic evulsion. Extensive atelectasis in the diseased lower zone and marked fibrosis have been observed. For high B.S.R. chronic tonsillitis and chronic rheumatism might be responsible.

Case 11.—P. A. Male. Aged 37. Past history: productive cough, night sweating, lassitude, subfebrile temperatures for several weeks. Admitted May 1947. Weight 9 st. 10 lb. T.B. Positive. B.S.R. 70 mm., 90 mm. X-ray: infiltration right mid zone, with " dorsal " cavity (2·5 by 2 cm.). Upper zones clear. Right phrenic crush and pneumoperitoneum July 1947. May 1949 excellent general condition. Persistently afebrile. Weight 9 st. 7 lb. T.B. Negative consistently for twenty-two months. B.S.R. 2 mm., 6 mm. Pneumoperitoneum still being continued. X-ray: right hemidiaphragm fourth anterior rib (regained its mobility nine months previously). No evidence of cavity for twenty-one months. *Comment.*—Basal onset. Phrenic paralysis and pneumoperitoneum caused prompt sputum conversion to negative, followed soon by disappearance of " dorsal " cavity in X-ray. The mechanism of cavity closure by kinking of draining bronchi is very likely in this case. An adequate rise of the hemidiaphragm has been maintained despite the fact that the paralysed phrenic nerve regained its function.

Case 12.—D. T. Male. Aged 47. Vague onset 1945. Admitted November 1947. Weight 9 st. 12 lb. T.B. Positive. B.S.R. 21 mm., 38 mm. X-ray: right " dorsal " cavity (3·5 by 2·5 cm.) with fluid level. Foci at right second anterior rib and in left apex. Right phrenic crush February 1948 (the paralysed diaphragm regained its function in June 1948) Right pneumothorax May 1948. Pneumothorax ineffective and abandoned June 1948 (inoperable pleural adhesions). Pneumoperitoneum treatment since May 1948. April 1949 good general condition. Weight 9 st. 13 lb. T.B. Negative consistently for six months. B.S.R. 12 mm., 24 mm. Pneumoperitoneum still being continued. X-ray: right hemidiaphragm fourth anterior interspace. No evidence of cavity for seven months. *Comment.*—Diaphragm was paralysed for four months

PLATE XI

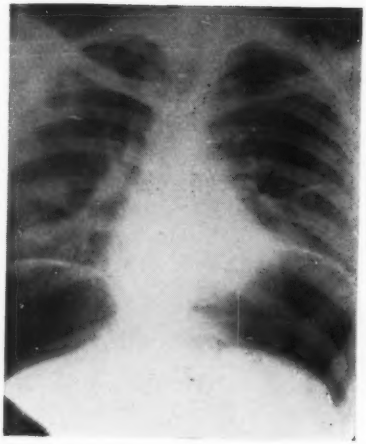

FIG. 4a

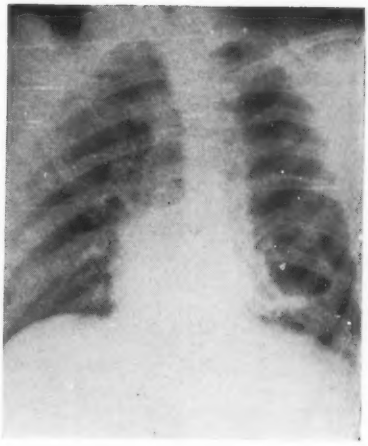

FIG. 4b

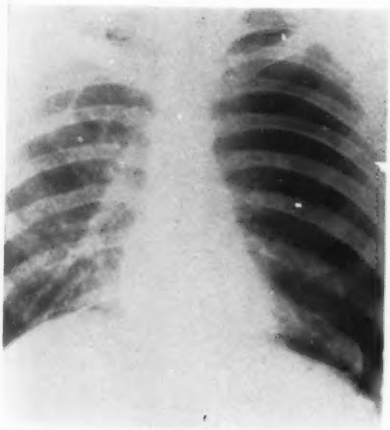

FIG. 4c

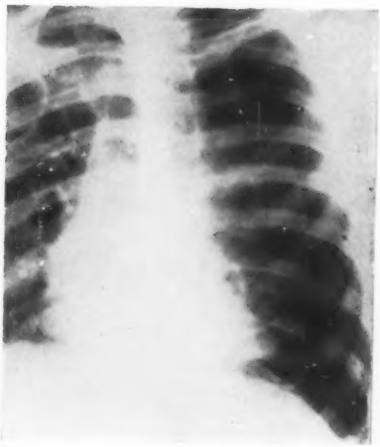

FIG. 4d

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only. Pneumoperitoneum by itself caused closure of " dorsal " cavity after four and half months of such treatment. Adequate diaphragmatic ascension. Pneumothorax ineffective due to inoperable adhesions.

Case 13.—W. J. Female. Aged 25. Past history: intractable cough, pain in chest, night sweating, lassitude, dyspnœa on exertion for four months. Admitted January 1948. Subfebrile temperature; pulse 92-120. Weight 9 st. 2 lb. T.B. Positive. B.S.R. 26 mm., 39 mm. X-ray: left " dorsal " cavity. Few foci in right first and second anterior intercostal space. Left phrenic crush and pneumoperitoneum April 1948. May 1949 excellent general condition. Afebrile. T.B. Negative consistently for twelve months. B.S.R. 2 mm., 4 mm. Pneumoperitoneum still being continued. X-ray: left hemidiaphragm fourth anterior rib. No evidence of cavity for ten months, cavity closure confirmed by tomograms. *Comment.*—Combined treatment with phrenic paralysis and pneumoperitoneum caused prompt sputum conversion, followed two months later by cavity obliteration (kinking of draining bronchi?).

Case 14.—M. Z. Male. Aged 28. Past history: cough, night sweating, increasing weakness, subfebrile temperatures since autumn 1943. Admitted November 1943. Weight 8 st. 7 lb. T.B. Positive. B.S.R. 18 mm., 38 mm. X-ray: cavity with fluid level in the right upper zone. History of previous right pleural effusion. Right phrenic crush September 1944. Pneumoperitoneum added July 1945. Cavity unaffected and pneumoperitoneum abandoned September 1946. Two-stage right upper thoracoplasty (seven ribs) December 1946. Cavity enlarged, measuring now 3·5 cm. in diameter (tension cavity). New infiltration right lower zone July 1947, progressed to cavitation (2·5 by .5 cm.) August 1947. April 1948—X-ray: right " basal " cavity, 3 cm. in diameter, with fluid level. Pneumoperitoneum and phrenic recrush May 1948. " Basal " cavity grew larger, measuring now 4 cm. in diameter; tension cavity. October 1948 poor general condition. Febrile (100°-101°F.). T.B. Positive. B.S.R. 6 mm., 26 mm. X-ray: right diaphragm fourth anterior interspace, both cavities unchanged. Streptomycin course followed in October 1948 (1·0 gm. daily, intramuscularly every twelve hours), and lasted four and a half months. June 1949 fairly good general condition. Afebrile. Weight 8 st. 2 lb. T.B. Negative consistently for five months. B.S.R. 5 mm.. 14 mm. Streptomycin course completed three months previously. Pneumoperitoneum still being continued. X-ray: right hemidiaphragm fourth anterior interspace. No apparent evidence of either cavity for six months. *Comment.*—Pneumoperitoneum in conjunction with phrenic crush ineffective in a case with two tension cavities. A systemic use of streptomycin added to the above-mentioned collapse measures caused after nearly two months sputum conversion and disappearance of both cavities in X-ray. However, it is too early to claim a definite cavity closure.

Case 15.—G. E. Male. Aged 22. Past history: productive cough, night sweating, lassitude, loss of weight, hæmoptysis on few occasions for six months. Admitted March 1948. Subfebrile. Weight 10 st. 5 lb. T.B. Negative. B.S.R. 10 mm., 26 mm. X-ray: segmental consolidation right upper zone. Remainder of lung field clear. September 1948. T.B. Positive. B.S.R. 23 mm., 57 mm. X-ray: consolidation right upper and mid zones with a " dorsal " cavity. Right artificial pneumothorax October 1948. Increase in size of cavity, followed by hæmoptysis. Partial intrapleural pneumolysis January 1949 (numerous thick and short adhesions, mostly posteriorly). June 1949 afebrile. Weight 10 st. 7 lb. T.B. consistently Positive. B.S.R. 25 mm., 45 mm. X-ray: artificial pneumothorax with effusion. Pleural adhesions. Cavity still visible. *Comment.*—Complete severance of pleural adhesions impossible. Eight months of pneumothorax treatment without success. Pleural effusion followed; tubercle bacilli have been found in the fluid.

This paper is based on a thesis accepted for the degree of M.D. by the Polish School of Medicine at the University of Edinburgh.

I submit my grateful thanks and appreciation to Dr. W. Tomaszewski, Senior Lecturer at the Polish School of Medicine, for much advice and generous help in preparation of this paper; and to Dr. J. Felix, Physician in Charge of the Department, for originally calling my attention to this work. My thanks are also due to many colleagues in this hospital for co-operation. My special gratitude is due to Professor Dr. Y. Rostowski, Dean at the Polish School of Medicine, for his kind permission to publish this paper; to Dr. Clifford Hoyle for his editorial help and criticism, and to Dr. S. Orlowski, Medical Administrator, for access to case records.

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SOLITARY CYSTIC DISEASE OF THE LUNG

BY JOHN ALMEYDA

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New names are mostly deceiving;
New theories are mostly false and useless;
New remedies for a time are dangerous.

SAMUEL BARD.

THIS aphorism seems appropriate in view of the present confused etiology and pathogenesis of these cysts. In this article I have used the term "solitary cystic disease of the lung" to mean a single cyst of bronchial or alveolar origin, arising in any one lobe of the lung. The non-expansile bronchial variety is termed "pneumo, or fluid, cyst," and the expansile variety "tension pneumo, or fluid, cyst," according to whether they contain air or fluid. The non-expansile alveolar variety is termed "pneumatocele" and the expansile variety "tension pneumatocele."

History

Meyers credited the first account to Nicholaus Fontanus in 1638, who found a "large bladder of air" (Kvôtis) communicating with the bronchi in each lung of a three-months-old baby, dying of cyanosis and acute respiratory failure. Bartholinus, in 1687, recorded the case of a four-year-old male child whose upper lobe of the left lung consisted of a "sac of air." The first English physician to describe this condition was Sir Thomas Barlow, 1880, when he recorded a case of "congenital atelectasis and emphysema" of the left upper lobe containing a "solitary cyst" the size of a chestnut, in a three-months-old

infant. In 1897 Stoerck reported the case of a male infant who had a very large cyst in the right upper lobe, which he called " fœtal-bronchial adenoma." Until two decades ago these cysts were only revealed by autopsy, but now they can be detected in the living through improved diagnostic methods. The early cases reported are those of Anspach and Wolmann's infant case, Crosswell and King's infant case, Schenck's cases and Hudson's infant case. These cysts had generally been considered as congenital, but more recently several observers (Rohmanyi and Maccone, Peirce and Dirkse, Benjamin and Childes, Caffey, etc.) have suggested that they are acquired, on the basis of their inflammatory history and biopsy findings. They considered that " true congenital cysts " were very rare, and that the assumption of their congenital nature was based upon insufficient evidence, which was partly due to a lack of a clear past history, or an incorrect assessment of past respiratory illnesses. Benjamin and Childes preferred to use the term " localised bullous emphysema " instead of " cysts " or " cystic," since they felt these terms would lead to confusion with " true congenital pulmonary air-cysts."

Etiology

While some authors (Peirce and Dirkse, Charr and Weiss, Benjamin and Childes, Caffey) have submitted sufficient evidence to prove the alveolar origin of their cases, others (Anspach and Wolmann, Feilde and Rosenberg, Grundy) have histologically determined the bronchial origin of their cases. I have come to the conclusion, after studying their cases and my own, that the occurrence of solitary cysts of the lung can be the result of either congenital or acquired defects of the bronchial, or alveolar, structures.

Pathogenesis and Mechanism

It must be noted that a bronchial solitary cyst may be air, or fluid, filled, whereas an alveolar solitary cyst is always air filled. Their mode of formation can be explained by both the congenital and acquired theories. According to the congenital view, the bronchial type would be formed during the early period of embryonic development, whereas the alveolar type would develop at a later period. According to the acquired hypothesis, the bronchial type would arise from early bronchial obstruction and inflammatory changes in the bronchial linings, causing cystic dilatations distal to the obstruction, whereas the alveolar type would arise either from interstitial inflammatory changes in the lung parenchyma, inducing sufficient lung contracture and consequent cystic dilatation of the lung unit, or from inflammatory, or necrotic, changes in the bronchiole, or peribronchiolar tissue, causing rupture and dissection of air into the alveolar space. In both types, when the bronchiolar communications remain free and patent—*i.e.*, possess a by-pass valve effect—the cyst remains non-expansile and small. The intra-cystic pressure is at atmospheric level and there is no bronchiolar distortion or displacement of the intra-thoracic structures. When the bronchiolar communication is tortuous and kinked, the mechanism involved is of the check-valve type—*i.e.*, it allows ingress but no egress of air, and the cyst becomes expansile until its intracystic pressure is balanced by (*a*) the resistance of the surrounding struc-

tures, or (*b*) the resistance of the cyst-wall and its trabeculæ, or (*c*) the efficiency of the collateral respiratory circulation. It is at this stage that the secretory function of the bronchial glands, present in the cystic walls and septa, becomes arrested.

Morbid Anatomy

The bronchial type of solitary cyst is situated usually on the anterior surface of the upper, or middle, lobe of the lung. If it has an expansile character it may attain such huge proportions that it occupies the whole lung. The rest of the lung is compressed, but the pleura remains non-adherent and strips easily. On section, the cyst appears multi-loculated with a spongy trabeculated appearance, having smooth, glistening and parchment-like walls which are lined with cubical epithelium, stratified and ciliated. The atypical arrangement of the cartilage, smooth muscles, fibres, bloodvessels and lymphatics is a characteristic feature. The cyst itself may contain air, or gas, under tension, or chylous-like fluid, or, if infected, purulent fluid and blood. There is displacement of the mediastinum and heart in the expansile type.

The alveolar type is nearly always associated with, or subsequent to, a respiratory infection (lobular, or aspiration, pneumonias). The rest of the lung is not collapsed. The pleura may be adherent and stripped with difficulty. On section, the cyst may appear multi-loculated with a lattice-like arrangement, or as a round space, while its walls are thin, translucent, glistening and smooth, and lined with stratified pavement epithelium, or endothelium; pigment may be present. The cyst contains air, or gas, and, occasionally, a very slight amount of chylous-like fluid, but it is not infected as a rule. If it is expansile, it may attain giant proportions, but never bring about displacement of the trachea, mediastinum or heart.

The bronchial communication in the non-expansile variety of both types is not tortuous and has a normal lumen, whereas the bronchial communication of the expansile variety of both types is always tortuous and has a kinked lumen, which gives it the check-valve action.

Clinical Findings

From the clinical records of the Royal Chest Hospital over the last fifteen years I have collected twelve cases of solitary cystic disease, nine of which have been under my observation. Eight cases (Nos. 1-8) were alveolar and four (9-12) were bronchial. All of them have been radiologically determined, but only one confirmed by autopsy. Although it is said that the bronchial type is mostly detected in infancy and early childhood, while the alveolar type is seen at any age period, only one bronchial case of early childhood was actually detected in this series. However, I feel this is not a true figure, because three of the cases gave a suspicious history of respiratory illnesses from early childhood, and hospital treatment was only sought after the cysts had become secondarily infected. Eleven of the cases were males and two females, giving a ratio of 5 to 1. No case gave a familial incidence. Eight cases gave a history of indoor work and four of outdoor, but I noted that only one case was concerned with a dusty trade. Antecedent illnesses, in their order of frequency, occurred thus: Cases 4 and 5—gassed; cases 5, 7, 8 and 11—influenza;

case 10—measles and empyema. No case was associated with any congenital anomaly.

The mode of onset was sudden in all the cases and the symptom-incidence was as follows:

Chronic cough—all cases;
Sputum—12 cases (purulent—3 bronchial and 3 alveolar; mucoid—4 alveolar and 1 bronchial);
Hæmoptysis—4 cases (3 bronchial and 1 alveolar);
Dyspnœa—9 cases (3 bronchial and 6 alveolar);
Night-sweats—5 cases (3 bronchial and 2 alveolar);
Thoracic pain—9 cases (2 bronchial and 7 alveolar);
Lassitude—4 cases (2 bronchial and 2 alveolar);
Fever—3 cases (3 bronchial only);
Loss of weight—2 cases (1 bronchial and 1 alveolar).

Cases 4, 5 and 8 were tension pneumatoceles; cases 2, 3, 6 and 7 pneumatoceles; cases 9 and 12 non-expansile pneumo and fluid cysts respectively; cases 10 and 11 expansile tension pneumo and fluid cysts respectively. There appeared to be no predilection for any particular lung, lobe or part of a lobe: the right lung was affected in 9, the left lung in 4, and both lungs in one. In cases 1, 4, 5 and 9 the right upper lobe was involved; in cases 5 and 11 the right middle lobe; in cases 10 and 12 the right lower lobe; in cases 1, 2, 3 and 7, the left upper lobe; and in case 8 the left lower lobe.

Bearing in mind the fact that all these findings are dependent on (*a*) the degree of cystic development—*i.e.*, the amount of intracystic pressure exerted on the intrathoracic structures; (*b*) the intracystic contents (air or fluid); (*c*) the presence, or absence, of secondary infection, and (*d*) the presence, or absence, of rupture into the pleura, the cystic condition in the non-expansile cases was found to remain clinically silent and was only detected by a "cyst-conscious" physician in the course of a routine chest radiographic examination; while the cystic condition in the expansile cases simulated in many respects a localised or complete pneumothorax or hydrothorax.

A *bronchial solitary cyst* is mostly seen in infancy or early childhood. Recurrent bouts of acute respiratory infection usually reveal its presence. The main symptoms are increasing progressive dyspnœa, a feeling of tightness and oppression on the affected side, and an unproductive spasmodic cough. Respiratory distress in the expansile type may become so acute that the laboured breathing may reach the point of asphyxiation with deepening cyanosis. Sputum, if present, is frothy and mucoid, occasionally streaked with blood. Physical examination may reveal diminution in stature but no emaciation, finger-clubbing, bulging or prominence of the affected side of the chest. Only in the expansile type is there any mediastinal, cardiac or tracheal displacement to the unaffected side. Over the affected area the note is hyperresonant or dull, and breath-sounds absent. If a needle be inserted air or fluid are released under pressure, causing immediate relief of symptoms. The cardiac rate may be increased, although the rhythm, sounds, electro-cardiographic tracings, and circulation times remain unaltered. Chest X-ray reveals a bold, thick, annular outline, which surrounds an air-filled space or a dense

shadow, with obliteration of the pulmonary markings. There may be slight haziness, or compression, of the rest of the lobe, which shows as an irregular narrow streak; and in the expansile type the trachea, mediastinum and heart are displaced to the unaffected side. In serial X-rays, one notes the stationary nature of the shape and appearance of the cystic space, and the absence of atelectasis. A bronchogram reveals the position, size and relation of the cyst to the surrounding structures; the communicating bronchiole appears to have a normal lumen. Contrast-oil enters the cystic space with difficulty and, when introduced through the aspiration needle, is seen to enter the bronchiole very slowly. Thoracoscopy may confirm the absence of pleural adhesions and pigment on the cyst wall. Biopsy will establish the type of epithelium lining and so determine the pathology.

An *alveolar solitary cyst* may be detected at any age period. The subject may be a normal, healthy individual with a clear antecedent respiratory history. The mode of onset is sudden, but in the expansile type it is never fatal though dramatic in nature. In the majority of cases, however, its presence is only detected in the course of routine chest radiological examination during, or following, a pneumonia or bronchial obstruction. The main symptoms are increasing dyspnœa, unproductive cough, asthmatic attacks, thoracic pain and cyanosis; all of which are progressive and fluctuating, but, unlike their bronchial counterpart, tend to disappear in a short time. Physical examination reveals normal development, no displacement of trachea and heart, resonant percussion note, absent or very distant breath-sounds, and unaltered cardiac rate, rhythm, sounds, electro-cardiographic tracings, blood-pressure readings and circulation times. Chest X-ray shows a thin, sharply defined smooth shadow, almost like a white pencil line, curved or annular, surrounding an air-filled space of lessened density, which occupies a localised portion of the side in the non-expansile type, but the whole side in the expansile type. The lung markings are diminished or absent, while the diaphragmatic leaf is depressed and peaked, with hardly any tracheal, mediastinal or cardiac displacement. After needle aspiration, the air-filled space is seen to permanently diminish in size. A bronchogram reveals a normal bronchial tree and determines the position, size and relation of the cyst to the surrounding structures. The bronchiole, communicating with the cyst, is seen to have a kinked lumen and contrast-oil fails to enter the cystic space. Thoracoscopy shows the presence of pigment in the cyst-wall and pleural adhesions. Biopsy establishes its alveolar origin.

Differential Diagnosis

Since solitary bronchial or alveolar air-filled cysts can be mistaken for complete or localised pneumothorax, or for diaphragmatic hernia, and solitary bronchial or alveolar fluid-filled cysts for localised encysted empyema, lung abscess, tuberculous cavitation, parasitic cyst, mediastinal cyst, chondroma or ganglioneuroma, it is necessary to differentiate them.

Pneumothorax (complete or localised) is a rare condition in infancy and early childhood. Thoracentesis reveals air under pressure which, when removed, allows re-expansion of the collapsed lung. X-rays show a well-defined border of the collapsed lung, the irregular shape of the air-space with

absence of strands of fibrous tissue, while serial X-rays shows absorption of the air-space over a period.

Diaphragmatic hernia is nearly always noted in the left chest, but parasternal types have also been detected. The characteristic gurgling sound is usually heard, while barium in swallow or meal can be seen to enter the affected area, which is none other than the thoracic loculus of the stomach.

Localised encysted empyema gives a recent history of infection with pyrexia and rigors. There is a marked retraction of the thoracic wall with approximation of the ribs. Thoracentesis reveals pus and organisms, while X-ray shows a triangular or fusiform shadow which conforms to the thoracic cage with much pleural thickening. Manometric induction pneumothorax registers a negative pressure. Thoracotomy reveals marked periosteal reaction on the inner surface of the overlying ribs, thickened pleura, anthracotic pigment and a fibrotic granulating surface, while drainage of the pus effects a permanent cure.

Lung abscess (putrid and non-putrid) also has a recent history of infection with pyrexia following some surgical condition of the upper respiratory tract or a localised infection or the aspiration of a foreign body. X-ray shows an ill-defined shadow, often annular, with surrounding pneumonitis. Lipiodol does not enter the cavity.

Tuberculous cavitation has the symptoms of loss of weight, lassitude, anorexia, persistent cough with nummular sputum, recurrent hæmoptysis, night-sweats, fever and increased pulse rate, together with variable physical signs of fibrosis, pneumonitis, and cavitation. A positive sputum and Mantoux test and the presence of elastic fibres in the sputum are confirmatory factors. X-ray may reveal a fibrosis or a pneumonitis with cavitation, where the cavitation is not truly annular, its walls are dense and broad, and there is usually surrounding pulmonary infiltration; in addition, other tubercular foci are usually seen in the same lung field—*e.g.*, a Ghon or Assman focus.

Hydatid cyst is a rare condition in this country. The cyst is usually basal and its diagnostic features are finally determined by an examination of its contents and the anaphylactic reactions.

Dermoid cyst is usually located in the mediastinum, but cases have been described of its appearance in the lung; both can be demonstrated by X-ray and bronchography. The post-operative findings and the histological examination are sufficient to establish the diagnosis.

Chondroma and fibroma are conditions which usually have a traumatic history. They are free from sepsis and their position which may be thoracic or extra-thoracic, can be confirmed by X-ray topography. Biopsy section of these tumours will establish their pathology.

Complications

Apart from the possibility of confusing solitary cysts with the above-mentioned diseases, there may also arise the following complications, which are here annotated in their order of frequency.

Secondary infection, which is only seen in the bronchial type, may be the result of an upper respiratory infection or a lobular aspiration pneumonia.

Spontaneous pneumothorax, which is more commonly associated with the

alveolar type, is usually the result of spontaneous rupture, but it may follow needle aspirations or induced pneumothorax for diagnostic purposes.

Hæmocyst and broncho-pleural fistula, which are seen only in the bronchial type, may be due to thoracotomy with drainage, or lobectomy or pneumonectomy.

Prognosis

With regard to the prognosis of solitary cystic disease, a study of my cases and the current literature leads me to the conclusion that, in the bronchial type, the mortality rate is high in infancy and early childhood, particularly in the traumatic giant grade, while in the alveolar type the mortality is slight in all its grades. With secondary infection or rupture of a bronchial cyst the prognosis immediately becomes grave, but these same complications in the alveolar type do not affect the prognosis. Excision, lobectomy or pneumonectomy have greatly improved the prognosis, especially for non-complicated bronchial cysts.

Treatment

The management of solitary cystic disease is largely dependent on the type, the presence of complications and the age of the patient. Since the alveolar type is not usually fatal and tends to disappear in time, treatment should be symptomatic; if, however, the condition is persistent, it should be aspirated, but care should be taken to combat the initial shock (Crosswell and King). With regard to the bronchial type, there appears to be general agreement that, in conditions that are unquestionably congenital, medical treatment will be at most palliative, whereas surgical intervention, wherever possible, appears to be the method of choice. In the giant bronchial grade, which is nearly always fatal, temporary relief may follow needle aspiration but, since the cyst rapidly fills, its thin wall may tear where it has been punctured and a tension pneumothorax may become an additional complication; in fact, nearly all cases so treated have died from shock, asphyxia or infection. Suction drainage through a flanged intercostal catheter may be helpful, but, in view of the purely mechanical hazards of the condition, it would seem to be a wise course to follow such an aspiration of air by an immediate operation, such as excision of the cyst, lobectomy or pneumonectomy. In the other bronchial grades, which may be symptomless, a watching brief should be adopted. If an operation is finally decided upon, it should be remembered that these cysts have no true capsule, that they cannot be shelled out of the lung, and that the adjoining lung appears as an appendage to the cysts; consequently, pneumonectomy is the easier and more successful treatment, although lobectomy, however, has been performed with success (Edwards) and appears to be the right approach in cases where the cyst is confined to a single lobe. Carter, Longacre and Quill have shown experimentally that adjustment to pneumonectomy is far more satisfactory when the operation is performed before the growth of the cyst has ceased and infection made its appearance. A cure has been obtained in some cases by cauterisation of the bronchial opening into the cyst and its walls, or by its closure with a ligature (Feilde and Rosenberg). In infected cysts, marsupialisation, followed by drainage, should be carried out for as long as six weeks, to avoid " spill-over," before the radical measures enumerated above are undertaken.

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PLATE XII

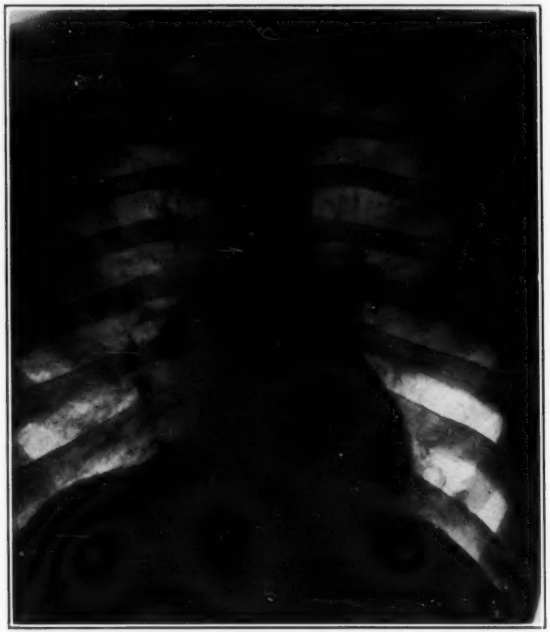

FIG. 1

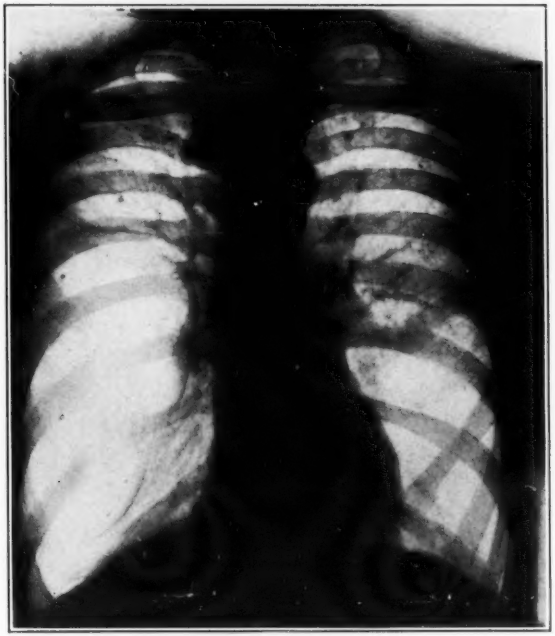

FIG. 2

Summary

1. New terms have been suggested for solitary cystic disease of the lung—namely, pneumo, or fluid, cyst and tension pneumo, or fluid, cyst instead of non-expansile and expansile bronchial cyst respectively; pneumatocele and tension pneumatocele instead of non-expansile and expansile alveolar cyst respectively.

2. The pathogenesis and mechanism have been discussed in the light of recent knowledge.

3. The clinical findings in 12 cases are reviewed and analysed.

4. The historical and etiological features, the morbid anatomy, differential diagnosis, complications, prognosis and treatment are discussed.

Appendix

Case 1.—H.T., male, 30 years, sand-blaster.

4.2.41. Pain in chest, back and front, two weeks after pneumonia; slight cough; scanty mucoid sputum; slight breathlessness; past history uneventful; family history not significant; heart and lungs normal on physical examination; X-ray chest (Fig. 1) showed two well-defined ring shadows in left lower lobe; B.S.R. 1 mm.

4.3.41. Occasional pain in left chest; normal heart and lung on physical examination; X-ray chest showed no alteration in shape, size or density of annular shadows in left lower lobe; B.S.R. 3 mm.

4.11.41. Occasional pain in left chest posteriorly; normal heart and lungs on examination; X-ray chest no change; B.S.R. 2 mm.

Persistence of shape, size and density of annular shadows in left lower lobe for ten months suggests that they are acquired alveolar cysts, coincidental with a recent attack of pneumonia.

Case 2.—R.B., male, 36 years, bus-driver.

8.4.38. Five-hour history of sudden, severe pain in right chest, increasing dyspnœa and dry cough; no cyanosis; impaired movement, hyper-resonant percussion note and absent breath-sounds of right chest; X-ray examination revealed right spontaneous pneumothorax; B.S.R. 9 mm.; sputum negative.

11.4.38. Almost complete compression of right lung; superimposed atelectasis of right upper lobe; bulla at left apex.

25.4.38. Right lung re-expanding; bulla visible in right apex.

7.7.38. Right lung fully expanded; no pulmonary infiltration; bulla still present in right apex.

The probable cause of the S.P.T. was rupture of the pneumatocele, which was revealed on re-expansion of the compressed lung. Again, the presence of atelectasis is not an uncommon feature in these cases. Presence of pneumatocele in the contralateral apex suggests some congenital weakness.

Case 3.—K.B., female, single, 40 years, cook.

7.12.34. Five-day history of sudden, severe pain in left chest, increasing dyspnœa, distress and aphonia; past history—left spontaneous pneumothorax 1½ years before, and operations for umbilical hernia, appendicitis, cyst in bladder and adenoma of right lobe of thyroid; no cyanosis; trachea to the right; diminished movement, hyper-resonant note and absence of breath sounds in left chest; cardiac dullness to right of sternum; X-ray chest—S.P.T. left lung; B.S.R. 6 mm.; atrophic laryngitis and rhinitis; sputum negative; Mantoux positive 1/1000.

11.12.34. Left S.P.T. with large bulla in both lungs (X-ray).

11.1.35. Slight re-expansion of left lung; bulla still present in both apices (X-ray).

Probable cause of S.P.T. was the rupture of the pneumatocele whose presence was revealed on the re-expansion of the lung. Congenital defect in the lung was surmised from the history of the recurrent S.P.T. and bulla in the contralateral apex.

Case 4.—R.S., male, 51 years, clerk.

28.5.35. History of a dry cough, since being gassed in 1917; easily tired; dyspnœa, no

sputum or pain, weight steady; trachea to left, right chest larger than left—expansion poor, percussion note hyper-resonant and breath-sounds absent; X-ray—trachea and mediastinum to left, aorta unfolded, intercostal spaces of right chest widened and horizontal, air-filled space with obliteration of lung markings filling upper two-thirds of right chest, right diaphragm depressed, flattened and peaked, right costo-phrenic angle obliterated, right lower lobe compressed to form a narrow streak.

13.7.35. Symptomless with physical signs as before; X-ray chest—air-filled space and appendages unchanged.

The absence of gross symptoms, particularly sudden thoracic pain or trauma, makes the diagnosis of a tension pneumatocele probable, as the result of the radiological appearances and the association of atelectasis.

Case 5.—R.D., male, 45 years, milk-salesman.

8.7.36. History of recurrent bronchitis since 1920, with shortness of breath, cough and copious muco-purulent sputum, occasionally blood-stained; no cyanosis, but slight dyspnœa; chest contour normal, expansion poor, percussion note hyper-resonant over lower two-thirds of right chest, breath-sounds diminished and high-pitched, few râles in left lower base; heart normal; sputum negative; X-ray chest (Fig. 2)—trachea, mediastinum and heart normal, right chest showed markedly raised interlobar septum, right upper lobe compressed, mid and lower zones filled by two large thin annular air-spaces with obliteration of the pulmonary markings, and right lower and middle lobes compressed to form narrow streaks. Died 1940, within a few hours of acute pain in right chest with dyspnœa and shock.

Radiological appearances of thin annular air-spaces, with no displacement of mediastinum, and the presence of atelectasis of right middle and lower lobes makes the diagnosis of tension pneumatocele in these zones probable.

Case 6.—C.N., male, 28 years, baker's-roundsman.

31.10.39. Attack of sudden pleural pain on right side, with breathlessness while cycling 10 days before; past history of operations for gastric ulcer and cervical adenitis; physical signs—trachea to left, diminished movement, tympanitic note, absent breath-sounds in right chest; sputum negative; X-ray—right spontaneous pneumothorax.

14.11.39. X-ray (Fig. 3)—re-expansion of the right lung and presence of basal bulla. (Bronchogram.)

Like cases 2 and 3, this is one of pneumatocele which ruptured and caused spontaneous pneumothorax.

Case 7.—R.L., male, 52 years, porter.

3.6.35. T.B. dispensary X-ray shows left upper lobe lesion; considered non-tuberculous.

17.8.38. Recurrent colds, chronic cough and sputum, with pain in right axilla for the past four years; past history—pneumonia at 17 and 24 years of age; physical signs—impaired percussion note, diminished breath-sounds, bilateral post-tussive crepitations chiefly right upper lobe; sputum positive; B.S.R. 21 mm.; X-ray—bilateral P.T. upper lobes with cavitation, cyst or bulla in right upper lobe which had been pulled upwards by fibrous tissue.

17.9.38. X-ray appearances of left upper lobe like those in 1935, with cyst or bulla still present.

The left upper lobe appears to have a cystic lesion, or unusual form of emphysema, followed three years later by tuberculous pneumonitis. It is interesting to note that cystic lesions appear to arrest the spread of tuberculosis.

Case 8.—A.B., male, 49 years, tool-maker.

Chesty from birth, cough and sputum over many years but more persistent in past twelve months, with increasing dyspnœa of effort in past nine months.

24.5.47. Awakened from sleep by severe pain in left chest, following violent coughing, marked distress, cyanosis and dyspnœa; finger-clubbing, trachea to right, diminished movement, resonant percussion note, poor air entry in left base, generalised rhonchi, cardiac dullness to right of sternum; X-ray and screening—spontaneous pneumothorax left lower lobe, chronic bronchitis and emphysema, cardiac shadow shifted to right, raised and thickened left interlobar fissure; E.C.G. physiological, right axis deviation.

29.5.47. X-ray (elsewhere)—eventration of left diaphragm, with gas-bubble in stomach.

PLATE XIII

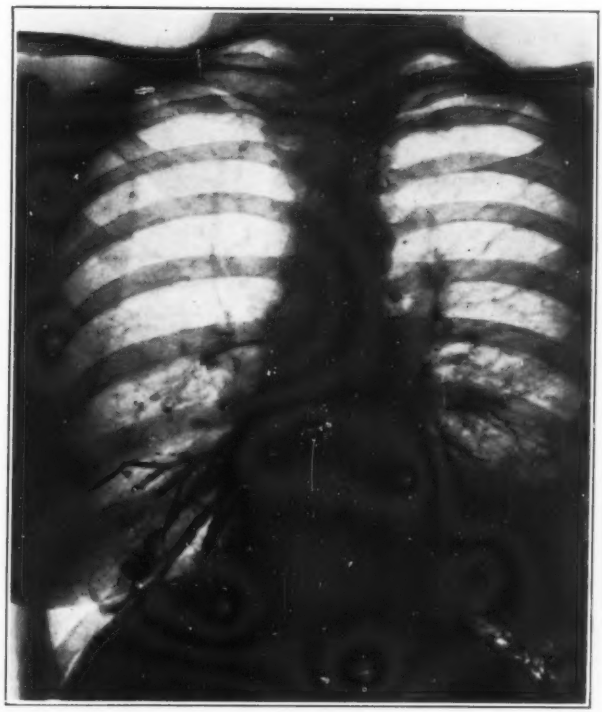

FIG. 3

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PLATE XIV

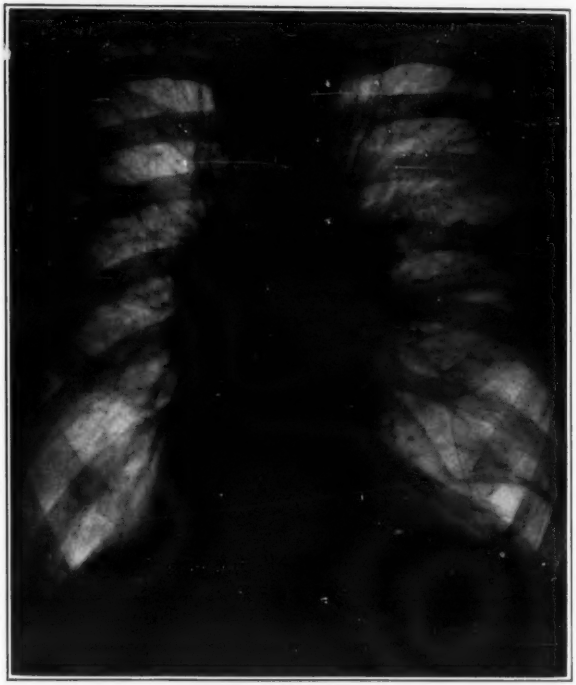

FIG. 4

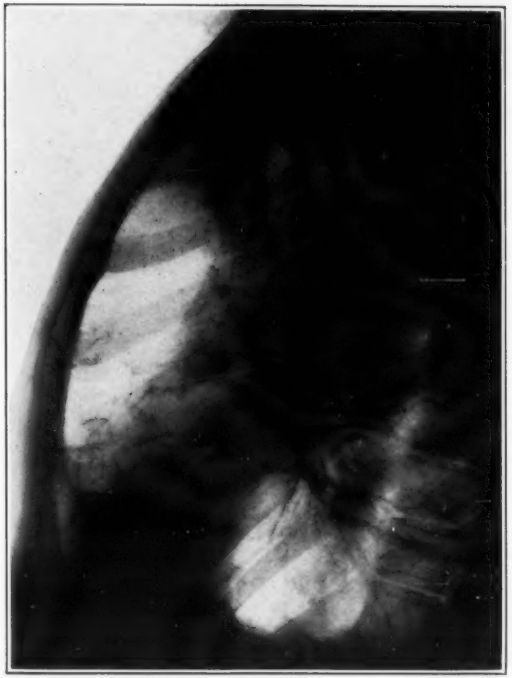

FIG. 5

10.6.47. X-rays (elsewhere)—fundus of stomach occupies the left chest, displacing the heart to the right, scarcely any diaphragmatic movement visible left side, very thin diaphragm leaf.

17.6.47. X-ray (elsewhere)—no change in eventration of diaphragm; sputum negative.

10.10.47. Symptoms and signs consistent with chronic bronchitis and spontaneous pneumothorax of left lung; X-ray (Figs. 4 and 5)—eventration of left diaphragm, thin diaphragm leaf, but above this a pencilled-line globular area suggestive of a tension-pneumatocele (similar picture seen in chest X-ray taken in 1944), no thoracic stomach.

15.12.47. Admitted, under Mr. Hunter for lobectomy, when large cyst of left lower lobe, which was adherent to anterior abdominal wall and pericardium, was removed without difficulty. Death followed ten days later from pneumonia.

Case 9.—H.R., female, 27 years, housewife.

21.9.33. Four weeks' history of cough, purulent sputum, pain in right chest; flattening, diminished movement, dull percussion note, bronchial breath-sounds and coarse râles in right upper lobe; sputum positive; X-ray—annular cavity in right upper lobe.

10.10.33. A.P. induced, but collapse unsatisfactory owing to pleural adhesion right upper lobe; phrenic crush six months later; X-ray revealed annular cavity R.U.L.; sputum positive.

17.6.46. Repeated X-rays since have shown no change in appearance of right upper lobe and the annular cavity; repeated sputa were negative.

The stationary character of the cystic space over a period of 12 years, which did contain tubercle until 1933, and the absence of infiltration of the surrounding lung tissue, appears to suggest that a cystic area has an arresting influence on tuberculous processes in the lung, and that tubercle bacilli are destroyed by the cystic fluid.

Case 10.—R.T., male, 20 years, shirt-maker.

21.9.33. At 6 years of age had empyema right base and broncho-pleural fistula; three years later was admitted for full investigations; bronchogram showed right basal bronchiectasis.

19.8.36. Admitted for recurrent hæmoptysis; clubbing of fingers and toes, bilateral Harrison sulci and funnel-shaped chest; diminished expansion, poor breath-sounds, and post-tussive râles right base; bronchogram revealed a small cavity at right base and bronchiectasis; bronchoscopy showed a small descending right bronchus.

24.7.41.—Physical findings as before; tomogram showed a large solitary bronchial cyst of the right lower lobe at 7 cm.

This case illustrates the presence of a true bronchial cyst which had ruptured into the pleura instead of emptying into a bronchus, and in so doing caused epithelialisation of the tract by eversion to keep the opening patent (broncho-pleural fistula). The condition was unable to return to normal until six years later. The cyst then failed to secrete and became air-filled and the opening sealed. Whether such a chapter in the life history of a cyst may be repeated can only be surmised.

Case 11.—F.W., male, 55 years, boot-repairer.

28.3.41. Aggravation of his chronic cough, sputum, shortness of breath, night-sweats and recurrent hæmoptyses, following an attack of influenza; some finger-clubbing, trachea to the right, and a depressed sternum; some flattening of right lower zone, impaired movement and percussion note, with poor air-entry and post-tussive creps in right base; X-ray—right basal fibrosis and bronchiectasis, with a large circular shadow; sputum negative; tomogram showed this cyst distinctly at 7 cm.; following an hæmoptysis the physical signs altered and X-ray did not reveal the circular shadow seen in the previous X-ray.

This case conforms to Peirce's definition of a true congenital solitary cyst—*i.e.*, an opaque globular shadow, present from birth, which at regular intervals ruptures into a bronchus, causing some shock, sero-sanguineous sputum and a radiological diminution in its size, only to fill up again and await a similar rupture episode.

Case 12.—I.S., male, Hebrew, 53 years, cap-machinist.

6.4.33.—Chronic cough and mucoid sputum for years, some loss of weight, and wheezy chest; finger-clubbing, dental sepsis and generalised basal rhonchi.

24.4.33. X-ray and bronchogram—chronic bronchitis and emphysema.
4.11.35. Several hæmoptyses and previous symptoms; physical signs of chronic bronchitis and emphysema; X-ray chronic fibroid phthisis and annular shadow in right lower lobe; bronchogram showed a normal bronchial tree, but the lipiodol did not fill the annular shadow.

In retrospect, the annular shadow is seen in the 24.4.33 X-ray and one can assume, in view of its stationary size over a period of years, that its communication with a bronchiole was kinked and so prevented the lipiodol from entering it.

I am indebted to Drs. F. E. Saxby-Willis, James Maxwell, Cedric Shaw, Courtenay Evans, Mr. John Hunter, Mr. A. M. H. Siddons, Dr. P. Kerley and Dr. N. Schuster for their courtesy in allowing me to make use of cases under their care in the Royal Chest Hospital.

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REVIEWS OF BOOKS

Pulmonary Tuberculosis. By KAYNE, PAGEL and O'SHAUGHNESSY. Revised by W. PAGEL, M.D.; F. A. H. SIMMONDS, M.D.; N. MACDONALD, M.B.; and L. FATTI, F.R.C.S. London: Oxford University Press, 2nd Edition. 1948. Pp. 720. Price 63s.

During the nine years that have elapsed since the first edition of this book, two of the original team of three co-authors have died. In addition, it has been a period which has seen great strides in many aspects of tuberculosis. As a result of these two main factors the book has, to a considerable extent, been re-written and increased by some 150 pages. The subject is divided into five sections, viz., pathology, diagnosis, prognosis, management and epidemiology. The first, and probably the most important, essential in the understanding of any disease, is a sound knowledge of its pathology. This aspect is dealt with in the opening section and comprises almost a third of the whole. It contains chapters on bacteriology, morbid anatomy, resistance and pathogenesis. Many new illustrations, some of them almost unique, are included: largely derived from the extensive personal experiences and ideas of the author, they provide most convincing evidence for his views, but contradictory evidence is sifted fairly, albeit somewhat severely. The critical examination of factors concerned in resistance and the pages on primary infection can be particularly commended.

The steps in diagnosis—from patient history—taking to the various ancillary measures are considered in their practical sequence, and in space proportional to their relative importance. The inadequacy of a simple diagnosis of a tuberculous lesion—without a full assessment of the degree of activity, stage in evolution, patient's resistance, etc.—is well shown when such aspects as prognosis and management are considered. Under treatment, the principles and aims of therapeutic measures—including their limitations—are the first consideration. A comprehensive account of collapse therapy follows, details of surgical technique having been reduced to a satisfactory minimum, and chemotherapeutic agents are reviewed in an appendix.

Whilst the authors have been able to draw on their own wide personal experiences, a work of this size necessitates a survey of a vast literature. A full bibliography follows each chapter, and there are surprisingly few important references omitted.

The book is extremely well printed and produced with liberal sub-headings in heavy type. Diagrams are clear and X-ray reproductions above the average. Advanced students and physicians dealing with pulmonary tuberculosis will find it a reliable account of the disease as we know it today, and a most useful reference work.

F. H. S.

Tuberculosis in History. By S. Lyle Cummins, C.B., C.M.G., LL.D., M.D. With an introduction by Sir Arthur Macnalty, K.C.B. London: Baillière, Tindall and Cox, 1949. Pp. xii+198, with 12 plates. Price 21s.

This book was the last work of the late Professor Lyle Cummins and was published only a short while before his death. He could not have left a more delightful memorial, since it shows to the full his questing mind and friendly personality. Those interested in the history of medicine in general and of tuberculosis in particular will find this book a real treat. The title is misleading: the author describes his book as " strictly designed to be a history of phthisis," but in fact he deals mainly with some of the men who have contributed to our knowledge of the disease. " A History of Phthisiologists " would be a more accurate title.

Starting in the seventeenth century, he gives us short biographical sketches of important tuberculosis workers and discusses their work. As always, one is impressed by the amazing powers of observation acquired by these old physicians. It is salutary for us, in this rapidly moving, scientific age, to find that so many things which we regard as modern were in fact observed centuries ago. Have we advanced so very far since 1720, when Christopher Benet prescribed the " non-naturals "—food, sleep, exercise, fresh air and a quiet mind—for his consumptive patients? Marten in 1719 anticipated the germ theory of the origin of phthisis, which he regarded as an infectious disease. Stark, whose work was published in 1780, gave a perfect description of " blocked " cavities, and James Carson, in 1821, not only demonstrated the elasticity of the lungs by animal experiment, but also showed the feasibility of pneumothorax treatment. Later he actually carried out the treatment in a few cases, so that Carson, not Forlanini, is undoubtedly the true father of collapse therapy.

Most of the workers described in this book belong to the British school, but the author devotes a section to Auenbrugger and Läennec who, because of their discoveries of percussion and auscultation, were responsible for the greatest advance in diagnosis in the era before X-rays. He rightly gives an honourable place to Villemin, who demonstrated the communicability of

tuberculosis fifteen years before Koch discovered the bacillus. Villemin infected animals by injecting them with tuberculous sputum, and successfully passed the disease to other animals. He also stressed the importance of contact infection, and showed that granulations could be present in the lungs without giving rise to clinical signs.

The work concludes with sketches of two outstanding figures in the history of tuberculosis: Trudeau, the founder of sanatorium treatment in America, and Robert Koch. In his account of Koch, the author succeeds in showing the great debt which posterity owes to him, without concealing his faults which included unwise deduction from his own work and contempt of the work of others.

Professor Cummins must have enjoyed writing this book; witness his delightful sketch of Sydenham, whose only real claim to inclusion was that he advocated horseback riding as a cure for consumption! He succeeds in communicating his enthusiasm to the reader, and his easy, conversational style makes reading a pleasure. The publishers have played their part by producing a handsome volume, on good paper, with excellent illustrations.

A. F. F.-C.

MEETINGS OF SOCIETIES

NATIONAL ASSOCIATION FOR THE PREVENTION OF TUBERCULOSIS

Second Commonwealth and Empire Health and Tuberculosis Conference
General Report and Summary of Proceedings

Over 1,100 representatives from more than fifty countries attended the NAPT Second Commonwealth and Empire Health and Tuberculosis Conference, at the Central Hall, from July 4 to 8 last. The Conference was a Commonwealth Conference; but tuberculosis, like other infectious diseases, cannot be isolated, and must therefore be considered from a world aspect. This point was emphasised by Dr. J. E. Perkins of the National Tuberculosis Association of the U.S.A., when he said at the first session of the Conference that, owing to modern means of communication, if tuberculosis was rampant in one country, no other country was safe. This first session dealt with *Tuberculosis as a World Problem*, and Dr. Perkins said that tuberculosis was still the leading cause of death in the younger age-groups in America, while in India the mortality rate was five times as great, and in China as bad or worse. He said that the first World Health Assembly had given tuberculosis top priority for action by the Secretariat, which might cause some people to ask why voluntary anti-tuberculosis work was necessary. But it was only through the pressure of public opinion that things got done quickly—" It was necessary for the people to demand that Governments should take steps." Dr. Perkins referred to the educational work of the anti-tuberculosis associations, and emphasised the part which could be played by the International Union Against Tuberculosis.

Dr. C. J. Beckwith (Canadian Tuberculosis Association) gave a summary of the measures of control in Canada—*i.e.*, case-finding with mass radiography as its sheet anchor; treatment, including streptomycin, and measures for rehabilitation. Dr. Beckwith emphasised the importance of prevention.

Dr. R. C. Adhikari (Bengal Tuberculosis Association) spoke of the wide increase of tuberculosis in India, where there were 500,000 deaths and 2,500,000 open cases per year. Mass radiography was practically unknown. Only 7,000 hospital beds were available, whereas 500,000 at least were required. "A sombre tale, unrelieved by any silver lining." Dr. Adhikari recommended a programme of mass B.C.G. inoculation.

Dr. J. B. McDougall, Secretary, Expert Committee on Tuberculosis, World Health Organisation, sent a paper which was read by the Secretary-General. The author said that various authorities had estimated the world deaths per year from tuberculosis at figures varying from about 2,000,000 to as many as 5,000,000. There was of course much variation in different countries: in some, the disease was fast coming under complete control, while in others the situation was very serious. A world survey of the problem was being undertaken by the World Health Organisation. In his paper, Dr. McDougall emphasised two especially important points with regard to the control of the disease: the spread of infection, and the question of inadequate nutrition. "The fight against tuberculosis," he ended, "is not a national or racial problem. It is a task for the whole of humanity."

The second session of the Conference was devoted to *Trends in the Modern Treatment of Tuberculosis, including Streptomycin and P.A.S.* Dr. Geoffrey Marshall (London) first referred to the Vice-Chairman, Sir Robert Young, who he said was greatly responsible for the progress achieved in our time in the treatment of tuberculosis, and was the leader of co-ordination and team-work in this country and elsewhere. Dr. Marshall then discussed various treatments for tuberculosis, many of which had proved valueless. He went on to deal with streptomycin, a treatment of great value but with unfortunate limitations. He mentioned the Medical Research Council's trial of streptomycin, which had been carried out with scientific controls of a stricter order than ever before in the trial of any treatment for tuberculosis. Streptomycin had achieved wonderful results in tuberculous meningitis—complete recovery in 40 per cent. of cases—whereas before, the death-rate was almost 100 per cent. In pulmonary cases, it was only useful for a short time, and only once for any one patient, owing to the development of streptomycin-resistant bacillus, but it could be an adjunct to other treatment if its limitations were realised. "Do not use streptomycin because it may be good for a patient," said Dr. Marshall, "but only when it is indispensable."

Dr. Marshall then stressed the importance of team-work in the treatment of tuberculosis, and said that first in order of value came the nurse. He spoke strongly about the closing down of beds for tuberculous patients because of the recent war, and said that there were still 5,000 out of action in this country, and that months went by before the patient could be sent to hospital. This was owing to the shortage of nurses, whose pay had been less than that of unskilled ward cleaners, and had not been much enhanced by the recent improvements, as the increased rates were mostly absorbed in income tax.

Professor Lehmann (Gothenburg) gave a description of work in Sweden with P.A.S. (para amino salicylic acid), a new drug which is now on trial in England. He said one of the values of this drug was that it could be given in large quantities for long periods of time. A report on a group of 205 pulmonary cases showed that, in the majority of them, progressive pulmonary tuberculosis had been converted into a healing phase. Intestinal tuberculosis cases had given perhaps the most satisfactory results with P.A.S. treatment—nineteen out of twenty showed definite improvement—and in 70 per cent. of uro-

genital cases the bacilli disappeared within a year. Professor Lehmann ended by saying that, possibly, combined treatment—*i.e.*, with streptomycin—might be the most successful in the end, and emphasised that these drugs could not be considered as a substitute for other methods.

Dr. J. G. Scadding (London) spoke of the splendid team-work which was being done, but said that these successes naturally led to a greater demand for beds. As beds could not be provided to the extent required, good work was being done in patients' homes by domiciliary collapse therapy. This required careful organisation and enthusiastic co-operation between physician, nurse and medico-social worker, and was a heroic effort to mitigate the difficulties imposed by the shortage of beds. In Hammersmith, out of 111 cases treated in this way, after a period of time 10 who were on the hospital bed waiting list were sufficiently improved to have their applications cancelled.

Dr. Pritchard (Southwark) gave an interesting description of the domiciliary treatment he had carried out, with excellent results. He said that the successful outcome depended very largely on the support of the health visitors.

Mr. Humphrey Neame made an interesting contribution to the session by discussing ocular tuberculosis. The next speaker, D. E. Rist (Paris), emphasised the importance of not overlooking the great value of pneumothorax. Dr. Geoffrey Todd (Midhurst), in summing up the session, said that the public should demand more beds. Good pay, good conditions and a good atmosphere for nurses were essential.

The first session on the second morning was devoted to a discussion of *Regional, County and County Borough Tuberculosis Schemes.* Mr. Anthony Greenwood, M.P. (Chairman), read a message from the Minister of Health, and said the question was how the new service with its dual control of treatment by regional boards, and prevention, care and aftercare by local health authorities, was working.

Sir Wilson Jameson (London) said that tuberculosis needed special arrangements. The great decline in mortality during the last fifty years was apt to make us complacent, but we should remember that there were nearly 22,000 deaths in England and Wales in 1948. He said he thought the new system was working well: local health authorities had wide powers, and could co-operate with tuberculosis specialists.

Several speakers representing Regional Board and Hospital Management Committees criticised the new Health Service in strong terms. In fact, the general tone of the discussion was to the effect that the old arrangements, in which tuberculosis work in all its phases was under counties and county boroughs, was much superior to the new plan. Again, the picture emerged of tragic conditions in homes in many places owing to patients waiting for beds, and pointed to the importance of (1) stop-gap domiciliary treatment; (2) preventive measures. Dr. Greenwood Wilson, of Cardiff, said that before the Act, when the Welsh National Memorial Tuberculosis Association was in being, the average waiting list of Cardiff patients for Association institutional beds was 72, and the average time of waiting 2 to 4 months. Now, the corresponding number was 158, and the time 3 to 9 months. The speaker referred to the closing without notice of 25 beds in the local isolation hospital which had been allocated for tuberculosis cases, and said this showed the weakness of all schemes divorcing the responsibility for institutional accommodation from the responsibility for community care. Dr. Wilson spoke of the " appalling conditions that are being piled up in patients' homes, while open cases of pul-

monary tuberculosis, many of them with young children swarming over them, wait, hopeless and helpless, for the institutional bed that never comes." His remarks, he said, were based on a health visitor's report, which was like a picture of leprous homes in this country in the Middle Ages—domestic help was lacking, as the official " home helps " would not come for fear of infection, and neighbours would not enter the houses, or even pass in a plate of food or a cup of tea. The Care and After-Care Committees had dealt with the situation as far as possible by obtaining part-time casual home helps, trying to remove children exposed to infection to children's homes and camp schools, where they hoped very soon to inoculate them with B.C.G.

Councillor Hardman (Wrightington, Lancashire) also deplored the fact that " tuberculosis schemes, delicately built up on expert advice by representatives democratically elected, schemes well tried, were being challenged and literally hacked about by untried hands," while all the time people's lives were at stake. He recommended the development of the separate Tuberculosis Committee and Department co-ordinating all effort in tuberculosis work.

Dr. A. B. Williamson (Leeds), while admitting the difficulty of divided responsibility, gave particulars of measures taken in his region to bridge the gap, which included the formation of a Technical Advisory Panel on Chest Diseases.

The afternoon session dealt with *The Organisation of Comprehensive Tuberculosis Schemes in the British Colonies.* Mr. Creech Jones referred first to the fact that bad social conditions, poor housing, deficient diet, and ignorance of hygiene were responsible for many diseases, particularly tuberculosis, and described what was being done in the Colonies in these respects. He referred especially to the importance of education of the Colonial peoples in both social and medical matters, and gave a résumé of the medical measures taken for the control of tuberculosis in Malaya—where there was believed to be an alarming increase in its prevalence—and in Kenya, Aden, Cyprus, Fiji and Hongkong. He stressed the importance of surveys by tuberculosis specialists from this country, and congratulated the NAPT on its Colonial Scholarships scheme, by which medical officers are enabled to come to England for a course of study, and on the one-hundred-guinea Colonial Essay prize for a study of Tuberculosis Control in a British Colony. It was announced that this prize had been won by Dr. Vincent Hetreed of Northern Nigeria, and also that six Scholarships for 1949-50 had been awarded: three to Malaya, one to Trinidad, one to Singapore, and one to a female nurse in Jamaica.

The situation was further explored by Dr. Charles Wilcocks, who discussed the relative values of social betterment and medical services where resources and finance were limited, and referred especially to tropical societies in the process of industrialisation where the danger of tuberculosis was great.

The Conference was honoured by a visit from the Rt. Hon. Philip Noel Baker, M.P., who said that, although in this present age more and more knowledge was being obtained, knowledge alone was not enough: it must be applied in a practical way.

Dr. R. B. McGregor, Director of Medical Services, Malaya, discussing the situation in Malaya, said that tuberculosis killed five times as many people as the terrorists, and gave some interesting statistics.

The session on Thursday morning, July 7, on *Problems in the Prevention and Detection of Tuberculosis*, was one of the most interesting and important. The Duchess of Portland, in the chair, said that it had already been emphasised that the basis of the cure of tuberculosis was good nursing, but the recruitment

of nurses was affected by the fear of tuberculous infection, so this important session would deal with methods of prevention.

Dr. Lundquist (Stockholm) discussed the position as affecting medical students and nurses in general hospitals as well as in sanatoria in Sweden, and said that there was no doubt that the tuberculosis rate amongst them was higher than amongst other groups; and also that B.C.G. vaccination, which had been in use for a term of from ten to fifteen years, had brought about a very noticeable reduction in the risk. Similar conclusions were drawn by Dr. G. J. Wherrett, of the Canadian Tuberculosis Association, who also drew attention to the importance of strict attention to protective measures with regard to clothing, washing, etc., and said: " We believe that a way can be found for nurses and others to attend the tuberculous sick in an atmosphere that will be as stimulating and attractive as other services, and with health hazards minimised to a degree that these workers will not be called upon to face health risks above and beyond those expected in the ordinary call of duty." Miss Nora Burrows, of NAPT Sanatorium Matrons' Section, read a very practical paper dealing with actual methods of prevention of infection, and said she felt these could be carried out in all hospitals. Miss Burrows also stated that the risk of infection was no greater for nurses in sanatoria than in general hospitals, in fact the rate was often less.

The session was admirably summed up by Dr. Marc Daniels, who stressed the almost unanimous agreement amongst the speakers on essential points as follows:

1. There was a danger of producing an exaggerated fear of tuberculous infection amongst hospital workers, but

2. There was also no doubt that there was a higher morbidity rate amongst them, and

3. It was possible by a number of measures, such as the taking of elementary precautions regarding clothing, masks, ventilation, care in post-mortems, etc., to reduce that morbidity. In some hospitals in this country, Dr. Daniels remarked, there was a complacency of a most remarkable kind about the hazards of tuberculous infection and a lack of elementary precautions which would be regarded with horror in ordinary hospitals. Masks were worn in relatively few hospitals, and sometimes nurses wore them, put them in their pockets, and then put them on again the other way round. There was also the use of B.C.G. to be further discussed later, but he hoped it would not give a false sense of security, as it did not provide complete immunity, and other precautions were still necessary.

The Duchess of Kent, President, NAPT, attended this session, and in her speech said: " Even in our own lifetime we have all of us known enormous changes in the attitude to tuberculosis. We have in the past looked upon this terrible disease as a menace to the health of our community, but we are now able to understand some of its power for evil, and through the use of preventive and other methods to reduce the number of deaths, so that we may indeed hope that the time is coming when tuberculosis will cease to be a serious problem. In this great work the spread of knowledge, both medical and social, is one of the most powerful influences." The Duchess ended by giving her best wishes to all who were helping in this great struggle.

A vote of thanks to the Duchess of Kent was proposed by Sir Austin Hudson, Hon. Treasurer, NAPT, and seconded by the Mayor of Westminster, who said that the City of Westminster had always taken a leading part in the campaign against tuberculosis.

The second half of the morning session, for part of which the Duchess of Kent remained, was devoted to a discussion of B.C.G. administration. Dr. K. A. Jensen (Copenhagen) presented a reasoned study of the effectivity of B.C.G. vaccine. Dr. P. V. Benjamin, of the Tuberculosis Association of India, in a most excellent paper, reaffirmed the magnitude of the problem in that country as stated earlier by Dr. Adhikari, saying that to establish adequate social and medical measures of control would cost about 10,000 million rupees: Dr. Benjamin felt that immediate measures for mass B.C.G. vaccination of the population offered the best possibility for a speedy amelioration of the situation and of an ultimate reduction of the magnitude of the problem, but stressed the point that it must be vaccination on a mass scale and carried out in the shortest time possible. The aim was to reduce mortality by four-fifths by vaccinating all tuberculin-negative persons in the space of five years, which would involve employing 200 teams at a cost of 60 million rupees a year, or 3 annas per head of the population. This would give time to build up the other necessary measures for the control of the disease, and incidentally reduce the size of the programme required. Dr. Benjamin described what had been done already: B.C.G. vaccination was started in India in 1948; a laboratory was opened and a number of B.C.G. centres set up in which Scandinavian teams are working and are also training a large number of Indian teams. It is hoped to reach the desired number of 200 teams by the end of 1950. Valuable help had been received from the World Health Organisation and from U.N.I.C.E.F., and Dr. Benjamin concluded by saying that as there was in India a certain amount of adverse criticism and propaganda, a statement from the present Conference on the usefulness and harmlessness of B.C.G. vaccination would be of very great value. Professor Wallgren, of Stockholm, then read a paper dealing particularly with the question of natural resistance to infection, and with the value of artificial specific immunity in compensating for a low natural resistance or in those exposed to special risk of infection.

The afternoon session of Thursday was devoted to a consideration of *Psychological and Social Readaptation of Chronic Disease in Industry*, and interesting contributions were made to the discussion by Dr. W. E. Chiesman, Medical Adviser to the Treasury, and others. The importance of industrial medicine with its preventive measures was stressed, because as Mr. Colton said in his summing up, the time may come when industry will have barely room for even fit men; and so the more the disease can be prevented, the less will be the need to rehabilitate the unfit. The same view was expressed by Dr. T. A. Lloyd Davis, Chief Medical Officer of Boots Pure Drug Company, who said: "The most obvious point about re-ablement is that it should never be necessary." Sir Frederick James, of Tata Ltd. (India), spoke amongst other matters of the great Charitable Trusts established by the Tata family for philanthropic, educational and scientific purposes, including the establishment of the first Institute of Social Science in India in 1936. Sir Frederick discussed the anti-tuberculosis schemes encouraged by the Tata organisation in its industrial enterprises, and stressed the importance of allowances during treatment, as otherwise the patient simply could not afford to be ill or to undergo treatment for his complaint. Sir Frederick ended by saying: " In the long run, the benefits of health and general well-being which flow from well-ordered schemes of social service and security are a paying proposition. The wise industrialist who realises this does not therefore always wait for the State to act." Turning to the problems of re-ablement, the question of social relationship was much to the forefront. As Dr. Lloyd Davis said: " The most

urgent need in re-ablement is that the patient should be returned to social contacts and purpose of work at the earliest possible date." Village settlements of the type of Papworth were generally approved, and Mr. Bertram Tallyn, Managing Director of Papworth, and Miss Olwen Taylor-Davis, Welfare Liaison Officer, gave accounts of the work and principles of the settlement, Miss Taylor-Davies making the very necessary plea that social legislation should not in itself be regarded as the remedy for social ills, but that it should be administered with special skill and understanding.

The final session of the Conference was on *Protection from Bovine Tuberculous Infection.* Professor W. H. Tytler, Chairman, said that there were two subjects for discussion: the elimination of tuberculosis from cattle, which would automatically solve the problem but was unfortunately a very long-term policy, and the interim policy of the provision of safe milk, which was technically simple and relatively inexpensive. Dr. Edith Summerskill, Principal Parliamentary Secretary to the Ministry of Food, spoke of the Milk (Special Designations) Act which comes into force in October, 1949, and enables the Minister of Food to specify areas in which all milk other than T.T. milk must be pasteurised, and said that the Act was the successful culmination of a long uphill fight against ignorance and prejudice. It was hoped to specify all urban areas within five years and most, if not all, rural areas within ten years. Dr. Summerskill referred to the increase in the production of T.T. milk and of heat-treated milk, which had been encouraged by the payment of premiums and allowances, and also mentioned the growth of attested herds (tuberculin-tested) which were now more than 16 per cent. of the cattle population of the country. There were between 1,500 and 2,000 deaths every year in this country from bovine tuberculosis, in addition to many thousands of cripples. Mr. John Francis, of the Biological Laboratories, Imperial Chemical Industries, said that the tuberculin test was the essential for control, and that in Denmark the proportion of tuberculin-tested herds rose from 30 per cent. in 1937 to 100 per cent. in 1948—a period of only eleven years. He also said that although he was not opposed to the pasteurisation of milk, it must be remembered it did not protect country dwellers from respiratory infection between cow and man, a subject much neglected in this country, but one which had been studied in Scandinavia, where in country districts 50 per cent. of pulmonary cases might be of the bovine type.

NOTICE

NAPT Scholarship for Scottish Nurse

A Scholarship of £100 to £150 will be awarded by the National Association for the Prevention of Tuberculosis to a registered female nurse working at the time of her application in a hospital in Scotland. The Scholarship will enable her to spend a period of from three to six months in postgraduate study, in hospitals or clinics in (*a*) Scotland, (*b*) England, or (*c*) Scandinavia.

Candidates should state age, qualifications and previous experience; reasons for wishing to do postgraduate work in tuberculosis; and should affirm their intention to continue in tuberculosis work after attaining the Scholarship.

Application should be made to Miss A. J. Weir, Scottish Secretary NAPT, 65, Castle Street, Edinburgh 2. by November 1, 1949.